

shown by some species concerns only the lower leaves. This variation is more striking in herbarium specimens than in the field.

*Inflorescences*: These may be solitary, axillary or arranged in cymose or racemose panicles so are to be regarded as a secondary taxonomic character which, together with habit and leaf form, are the characters generally used in field determination.

*Involucral bracts*: No marked differences were found in the shape or size of the involucral bracts in the various species and details of them were of no assistance in identification.

*Ray florets*: The colour of the ray florets, while of occasional assistance, is a character to be used with caution since on drying a change may occur from white to pink or blue, and from blue, pink or pale yellow to white on expanding from the bud. The deep yellow of *C. latiuscula* and others, however, is quite constant. Both *C. hispidula* and *C. squamigera* possess extremely minute rays which are usually exceeded by the stylar arms, but apart from these, the size of the ray is not a reliable character.

*Disc florets*: The colour and form of the disc florets are constant throughout the genus and in all but two species (*C. hispidula* and *C. squamigera*) their ovaries are abortive.

*Receptacle*: The degree of pitting varies with different species, but is an unreliable character to use in herbarium specimens since, on drying, shrinkage of the receptacle may influence considerably the depths of the pits. In both *C. scabiosifolia* and *C. cuneata* the tissue between the pits is extended to form 5-6 long scale-like structures around the base of each floret.

*Fruits*: Form, size and structure of the fruits constitute the primary taxonomic characters of *Calotis*, and of these, awn details are the most important. Since the awns are highly specialized structures with a very considerable survival value, they are of little or no guide to interspecific relationships and it is to be regretted that the only primary taxonomic characters found in this genus are ones so modified by selection.

#### TAXONOMY.

##### COMPOSITAE, tribe ASTEROIDEA.

*CALOTIS* R.Br., *Bot. Reg.*, t. 504 (1820).

*Synonymy*: *Huenefeldia* Walp., *Linnaea*, 14 (1840), 307; *Goniopogon* Turcz., *Bull. Soc. Nat. Mosc.*, 24 (1851), 173; *Cheiriloma* F. Muell., *Linnaea*, 25 (1852), 401.

Annual or perennial herbs, or occasionally sub-shrubs, with a varying amount of septate-hairy indumentum. *Leaves* entire or variously dissected, petiolate or sessile, radical and/or cauline. *Inflorescence* a capitulum, solitary, axillary or forming cymose or racemose panicles, heterogamous, rarely almost sessile. *Involucral bracts* green, septate-hairy on the outer surface, entire, and arranged in a compressed spiral to form 3 or occasionally 4 pseudowhorls. *Ray florets* female, ligulate, in 1 to several rows around the periphery of the capitulum; the rays white, pink, mauve, blue or yellow. *Stylar arms (ray)* linear, entirely receptive. *Disc florets* usually male with abortive ovaries, but hermaphrodite in two species, tubular, 5-toothed, yellow. *Stamens* 5, inserted on the corolla tube alternately to the teeth. *Anthers* obtuse at the base, with the connective extended beyond the level of the pollen sacs to form a lanceolate appendage. *Stylar arms (disc)* lanceolate, papillate, stigmatic lines only present in fertile florets and not enclosed by the arms. *Receptacle* hemispherical, pitted, naked except in two species where 5-6 scale-like filiform upgrowths surround the base of each floret. *Fruit*, an inferior achene, flattened, cuneate, smooth or tuberculate, glabrous or hairy. *Pappus* represented by awns which are usually rigid and armed with recurved barbs, but occasionally plumose and very rarely absent. Scales, alternating with the awns, are present in some species.

*Type species. Calotis cuneifolia* R.Br.

## Key to the Species.

1. Pappus represented by rigid awns alternating with an equal number of scales, or awns absent.
2. Awns 2-5.
3. Awns barbed only distally, otherwise smooth. Fruits glabrous.
4. Scales broader than long. Body of the fruit with a few minute tubercles.
5. Scales fringed at their free edges; awns 1-2, occasionally 3, with barbs in the form of a terminal arrow head. Erect sparsely branched perennials with broad-linear to oblanceolate, distally serrate or pinnatifid cauline leaves ..... 1. *C. dentic.*
- 5.\* Scales infolded distally so as to appear entire; awns usually 2, occasionally 3-4, barbed along distal half. Erect much-branched perennials with cuneate cauline leaves which are distally lobed and basally auriculate ..... 2. *C. cuneifolia.*
- 4.\* Scales longer than broad. Body of the fruit minutely but densely tuberculate. Erect or ascending perennials with pinnatifid leaves tapering into a broad petiole ..... 4. *C. glandulosa.*
- 3.\* Awns very finely but densely barbed along their whole length.
6. Erect perennials with ovate-cuneate to cuneate cauline leaves, which are proximally narrowed and auriculate, and distally coarsely serrate. Inflorescences on slender peduncles. Ray florets about 9 mm. long, disc florets sterile. Fruit glabrous; awns and scales 5-8, spreading, the scales entire and minutely ciliate at their free edges. Body of fruit sparsely and minutely tuberculate ..... *C. xanthosoidea.*
- 6.\* Procumbent annuals with cuneate-spathulate cauline leaves on slender petioles and distally toothed. Ray florets minute, shorter than or hardly exceeding the stylar arms; disc florets fertile. Awns and scales 4-5, erect or spreading.
7. Scales entire or very shallowly lobed; awns erect. Fruit glabrous, the body minutely and sparsely tuberculate. Inflorescences on extremely short peduncles so as to appear sessile ..... 6. *C. squamigera.*
- 7.\* Scales deeply dissected, often obscured by hairs; awns spreading, proximally hairy. Body of fruit hairy. Inflorescences on slender peduncles ..... 7. *C. hispida.*
- 2.\* Awns absent or in the form of a minute barbed lateral bristle arising from the collar-like circular scale. Body of the fruit tuberculate, glabrous. Erect branching perennials with oblanceolate mucronate-serrate and sessile cauline leaves ..... 3. *C. Kempei.*
- 1.\* Pappus represented by awns only; scales absent.
8. Fruits wingless.
9. Awns robust and rigid.
10. Awns 2-5, equal in length. Fruit hairy at the apex between and on the bases of the awns.
11. Erect much-branched perennials with numerous cauline leaves. Bases of the awns expanded and united.
12. Awns 2-4, coarsely barbed, when only 2, these arise in the same plane as the flattened face of the fruit. Fruit glabrous and smooth. Leaves sessile, broad-linear to linear-cuneate, serrate ..... 8. *C. erinacea.*
- 12.\* Awns 2, arising at right angles to the flattened face of the fruit, barbs are replaced proximally by a few hairs. Body of fruit glabrous, tuberculate. Leaves sessile, broad-linear to spatulate, coarsely serrate to pinnatifid ..... 9. *C. cymbacantha.*
- 11.\* Stolonerous perennials with a basal cluster of linear to linear-lanceolate entire leaves. Fruits with 5 awns, distally finely barbed and proximally hairy, not united at base ..... 15. *C. scapigera.*
- 10.\* Awns more than 4, of unequal length.
13. Major awns 2-3, finely barbed distally.
14. Major awns 2, at right angles to the flattened face of the fruit. Secondary awns barbed, in two groups of 3 and 1 or 5 and 3, members of each group shortly united at base, giving the fruit a 2-lipped appearance when viewed from above. Body of the fruit glabrous. Much-branched perennials with linear and entire or toothed to pinnatifid cauline leaves ..... 10. *C. lappulacea.*
- 14.\* Major awns 2-3 with no constant arrangement. Secondary awns not barbed, hairy, unequal. Branched perennials with narrow-oblanceolate to linear leaves, entire or with a single lateral tooth ..... 11. *C. glabrescens.*
- 13.\* Major awns 4 or more, usually barbed distally.
15. Awns with expanded and united bases, coarsely barbed. Fruits glabrous and smooth. Erect perennials with sessile, broad-linear to linear-cuneate, serrate, cauline leaves ..... 8. *C. erinacea.*
- 15.\* Awns free.
16. Stolonerous perennials with a basal cluster of linear and entire or variously shaped and dissected radical leaves.
17. Awns in a single ring, the longest distally barbed. Body of fruit with a central area of simple hairs or glabrous ..... 12. *C. scabiosifolia.*
- 17.\* A second ring of fine plumose awns present within the first. Longest awns distally barbed or smooth; smaller awns with a few barbs or entirely hairy. Body of fruit tuberculate or hairy on central area ..... 13. *C. cuneata.*

- 16.\* Erect (?) perennials with numerous oblanceolate to cuneate cauline leaves, dentate or entire, sessile. Radical leaves only present on young plants. Fruits with an expanded hairy central cone; awns twisted in various directions, minutely barbed distally, hairy proximally ..... 14. *C. latiuscula*.
- 9.\* Awns fine and flexible, without barbs but with numerous short straight hairs. Branching annuals with cuneate, toothed, cauline leaves ..... 16. *C. intermis*.
- 8.\* Fruits winged.
18. Body of fruits more or less hairy.
19. Awns coarsely barbed, 6-11, 0.5-1 mm. long; hairs on body and wing margins simple or forked.
20. Wings narrow, thick, not sharply demarcated, hairs along margins sparse. Awns equal to or slightly exceeding the central cone. Branching perennials with linear to narrow-oblanceolate entire cauline leaves ..... 17. *C. breviseta*.
- 20.\* Wings expanded and sharply demarcated, with numerous long hairs along wing margins. No central cone present on fruit. Branching annuals with narrow-cuneate to cuneate cauline leaves, toothed or acutely lobed .. 18. *C. porphyroglossa*.
- 19.\* Awns entirely barbed or barbs replaced by very short straight hairs, 12-24, 0.5-2.5 mm. long; hairs on body and wing margins simple or plumose.
21. Awns equal to or exceeding the length of the body of the fruit, fine and flexible, with short straight hairs or finely barbed; bases of the awns obscured by long white plumose hairs of the body and fruit apex. Plumose hairs form a dense border to the wings. Branching annuals with narrow-cuneate to cuneate distally toothed cauline leaves ..... 19. *C. multicaulis*.
- 21.\* Awns shorter than the body of the fruit, stiff but not rigid, with straight hairs along their whole length giving a plumose appearance, not barbed. Body and wing margins bear long stiff straight hairs; wings distally concave, their apices incurved. Sparsely branching (?) annuals with cuneate, distally toothed cauline leaves ..... 21. *C. breviradiata*.
- 18.\* Body of fruits glabrous.
22. Wings much expanded, anchor-shaped, with long simple hairs fringing their outer margins. Awns 15-25, 1-1.7 mm. long, stiff, with a few apical barbs and the remainder occupied by long simple hairs. Branching annuals with broad-linear to oblanceolate cauline leaves, with a few linear lobes ..... 20. *C. ancyrocarpa*.
- 22.\* Wings narrow, glabrous. Awns 7-14, 0.2-2 mm. long, rigid, minutely barbed distally, finely hairy proximally; apex of fruit forms a hairy and conspicuous central cone. Stolonerous perennials with a basal cluster of bipinnatiset radical leaves with long petioles ..... 22. *C. anthemoides*.

1. CALOTIS DENTEX R.Br., *Bot. Reg.*, 6 (1820), 504. (Text-figs. 1-14.)

*C. scabriuscula* C. T. White, *Proc. Roy. Soc. Q.*, 57 (1946), 31.

*Type data*: "In the neighbourhood of Port Jackson", R. Brown.

*Lectotype*, Port Jackson, R. Brown (MEL).

Erect branching septate-hairy perennials up to 82 cm. high. *Lower cauline leaves* up to 8 cm. long, very broad-linear to oblanceolate, distally serrate or dentate, occasionally pinnatifid with acute lobes 1.5 cm. long, 3 mm. broad. *Upper leaves* usually entire. *Inflorescences* up to 50, 1.1-3 mm. diameter, on axillary peduncles. *Involucral bracts* 9-15, 5.5-10 mm. long, 2.5-4 mm. broad, lanceolate to ovate, with acute to acuminate apices and entire margins. *Ray florets* up to 73, the rays 10 mm. long, 1.2 mm. broad, white. *Receptacle* 1.5-1.9 mm. high, hemispherical and shallowly pitted. *Fruits* reddish-brown, the body cuneate, 1.7-2.2 mm. long, 1.2-1.6 mm. broad, flattened, smooth or minutely papillate on each face. Pappus scales 2, broader than long and fringed distally, alternating with 2 distally barbed awns, 4.2-6.6 mm. long. Occasionally 3 awns are present, in which case a small scale separates the supernumerary from the closest normal awn. When only a single awn is present the scales form a single structure extending around the apex of the fruit.

*Habitat*: Forest country on sandy or loamy soils.

*Range*: Coastal and South-eastern Queensland, through New England and coast of New South Wales to Fitzroy Falls.

*Specimens examined*:

*Queensland*: Marlborough, 2.1918, H. W. Simon (BRI); Rockhampton, O'Shanesy (MEL); Gracemere, dry places, 1.11.1870, P. O'Shanesy (MEL); Bundaberg district, road to Gin Gin, N. Michael (BRI); Burnett River, F. Mueller (MEL); Gympie, F. H. Kenny (BRI); Benarkin, 5.1921, E. W. Bick and W. D. Francis (MEL); Spring Bluff,

on rocky hillsides in *Tristania conferta*-*Eucalyptus* forest on dark grey fine sand, ca. 1,500 ft.; 2-4 ft. high, ray white, 21.2.1935, S. T. Blake 7,717 (BRI); Flagstone Creek. 21.10.1934, N. Michael (BRI); Taylor's Range, 8.7.1844, L. Leichhardt (MEL); Brisbane, 8.6.1929, C. S. Sutton (MEL); Brisbane River, W. Hill (MEL); Camp Mt., top and upper slopes, 1,000-1,300 ft., common in *Eucalyptus* forest among grass on stony light grey soil, erect sparsely branched perennial herb of 1-1½ ft., ray white, 30.3.1945, S. T. Blake 15,493 (BRI); Moggill, in *Eucalyptus* forest on Brisbane schist, undershrub 2 ft. high, fls. white, 3.4.1931, C. T. White 7,264 (BRI); Jimboomba, 4.1907, J. L. Boorman (NSW 14,642); Gladfield, 6.1892, F. M. Bailey (NSW 14,647); Mt. Edwards, on lower slopes, diffuse herb about 2 ft., 1.4.1934, S. L. Everist 577 (BRI); Applethorpe, on granite sand, on flat, in stringybark forest, 22.11.1946, S. L. Everist and L. J. Webb 1,304 (BRI); Chesterton, in *Callitris* and *Eucalyptus* forest on very sandy soil, ca. 1,900 ft., 8.4.1936, S. T. Blake 11,140 (BRI).

*New South Wales:* Mt. Lindsay, 11.1912, H. M. R. Rupp (NSW); Boonoo Boonoo sandstone ridges by the side of the road, 11.1904, J. L. Boorman (NSW 14,666); near Timbarra, Marsh, C. Stuart (MEL); between Drake and Tenterfield, 15.12.1916, J. B. Cleland (AD); Torrington, J. L. Boorman (NSW 14,667); Emmaville, 10.1901, J. L. Boorman (NSW 14,642); Grafton to Dalmorton, 11.1903, J. H. Maiden and J. L. Boorman (NSW 14,661); Pheasant Creek, Glen Elgin, 12.1913, J. L. Boorman (NSW 14,664); Glen Innes, granite, 1.1914, H. M. R. Rupp (NSW 14,665); Tingha, 6.1917, J. L. Boorman (NSW 14,669); head of R. Gwydir, L. Leichhardt (NSW 14,662); Guyra, 6.1917, J. L. Boorman (NSW 14,643); Snowy Range, 4,500 ft., granite soil, *Eucalypt* forest, 11.3.1931, G. L. Davis (NE); Big Hill, Armidale-Kempsey road, ray blue, 3,000 ft., 27.1.1941, C. Davis (NE); Uralla, 3.1912, A. McNutt (NSW 14,656); Walcha Road, 12.1912, J. L. Boorman (NSW 14,668); Moona R., Walcha, 12.1884, A. Crawford (MEL); Macleay R., Beckler (MEL); Port Macquarie, 2.1898, J. L. Boorman (NSW 14,654); Rylstone road, red loam on roadside, 2,500 ft., 22.9.1948, E. F. Constable (NSW 14,707); Blue Mountains, Atkinson (MEL); The Peaks, Burragorang, 8.1905, R. H. Cabbage (NSW 14,657); Nepean R., 14.1.1888, J. J. Fletcher (NSW 14,653); Richmond, 10.4.1910, W. Greenwood (NSW 14,973); Norton's Basin, Nepean R., 17.11.1935, G. L. Rodway (FAR); Parramatta (MEL); Port Jackson, R. Brown (MEL); Centennial Park, Sydney, 12.1902, A. A. Hamilton (NSW 14,651); Carlton, 2.1893 (AD); Como railway station, 3.1893, J. H. Camfield (NSW 14,659); Glenfield, 27.12.1918 (NSW 14,652); Bargo, 26.1.1940, W. F. Blakely and W. J. Burkingham (NSW 14,972); 7 miles S.W. of Fitzroy Falls, forest, F. A. Rodway (NE; FAR).

Robert Brown described *Cálotis* from specimens of *C. dentex* collected by himself "in the neighbourhood of Port Jackson", some of which are in the National Herbarium, Melbourne, and from these a lectotype has been selected. The fruits of these specimens bear one awn, a condition noticed in a number of specimens, particularly in those from Queensland, and Brown himself stated (1820), "... from 1-3 barbed awns". This diagnosis of the species was followed by Bentham (1866), but White (1946) limited the name to cover only those plants with fruits "with 1-2 awns, and in the latter case one markedly smaller than the other". He then described those with two nearly equal awns as a new species, *C. scabriuscula*. In the specimens examined by the present writer, a continuous series was found in the fruits, from the one to the three-awned condition, passing through all degrees of inequality in length and not associated with any other differences. The attempt to divide a population into separate units on a single character with continuous variation can only be regarded as arbitrary, and in this revision the name *C. dentex* is applied in its original sense.

Members of this species are usually robust, rather coarse, leafy herbs with conspicuous inflorescences. They exhibit little vegetative variation except for the margins of the lower leaves (Text-figs. 4-13), which are sometimes rather deeply dissected, but this is more conspicuous in herbarium specimens than in the living state.





Text-figures 1-23.

1-14, *C. dentex*.—1, Habit  $\times 0.3$ ; 2-3, Variation in fruits  $\times 6.3$ ; 4-13, Variation in lower cauline leaves  $\times 0.3$ ; 14, Distribution; 15-19, *C. cuneifolia*.—15, Habit  $\times 0.3$ ; 16-18, Variation in fruits  $\times 6.3$ ; 19, Distribution; 20-23, *C. Kempf.*.—20, Habit  $\times 0.3$ ; 21-22, Variation in fruits  $\times 9$ ; 23, Distribution.

2. *CALOTIS CUNEIFOLIA* R.Br., *Bot. Reg.*, 6 (1820), 504. (Text-figs. 15-19.)

*C. dilatata* A. Cunn. in *DC. Prod.* 5 (1836), 302; *C. palmata* A. Gray, *Proc. Am. Acad.*, v (1861), 121; *C. cuneifolia* R.Br. var. *biaristata* Domin, *Biblioth. Bot.*, 89 (1929), 1208; *C. cuneifolia* R.Br. var. *glabrescens* C. T. White, *Proc. Roy. Soc. Q.*, 57 (1946), 30; *C. scabriuscula* C. T. White var. *lobata* C. T. White, *l.c.*, 31.

*Type data*: "Growing on the banks of the River Lachlan, 1817, Allan Cunningham."

Erect, ascending or sometimes prostrate much-branched perennials up to 60 cm. high, with an indumentum of stiff septate hairs. *Cauline leaves* numerous, the lower up to 4 cm. long, 2 cm. broad, cuneate with an abruptly expanded base and usually auriculate, with 3-6 acute distal lobes which are usually entire but occasionally are minutely toothed. *Radical leaves* with slender petioles, but only present on young plants. *Inflorescences* very numerous on established plants, on which 200 or more are not unusual. Individual inflorescences 1-2 cm. diameter, on terminal and axillary peduncles. *Involucral bracts* 16-29, up to 3.5 mm. long, 1.4 mm. broad, narrow-obovate to linear, entire, subacute to acute, glandular on the outer surface. *Ray florets* 27-45, the rays 3-9 mm. long, 0.5-1.5 mm. broad, white or lilac. *Receptacle* 1-1.9 mm. broad, 0.8-1 mm. high, conical, shallowly pitted. *Fruits* reddish-brown, the body 0.8-1.6 mm. long, 0.6-1.5 mm. broad, cuneate, flattened. Awns barbed distally, usually 2, but occasionally 3-4, 1-3.5 mm. long, alternating with an equal number of smooth uninfolded scales which are broader than long.

*Habitat*: On sandy soils or clay-loams among grasses in open Eucalypt forest.

*Range*: Widely spread in the eastern States, particularly in inland areas, with two records from south-eastern South Australia and Northern Territory.

*Specimens examined*:

*Queensland*: Torrens Creek, *Eucalyptus* forest, in sandy soil near Warrigal swamp, 20.3.1933, C. T. White 8,700 (BRI); west of Pentland, on slopes of Great Dividing Range on sand overlying sandstone, 1,500-1,650 ft., tufted, rather spreading and ascending to 1 ft., flowers scented, ray white, 19.10.1935, S. T. Blake 9,945 (BRI); Warrigal, in mixed *Eucalyptus* forest, on reddish-brown sandy soil, 2.2.1931, C. E. Hubbard and C. W. Winders 7,111 (BRI); 200 miles W. of Hughenden, 8.1889, C. Chisholm (MEL); Glenbar, common in *Eucalyptus* forest, heads purple-white, 8.2.1930, S. F. Kajewski (BRI); Canal Creek, 1882, Hartmann (MEL); Rockhampton, G. O'Shanesy (MEL); Dundee Sta., in red-brown fine sandy loam with Box, Mulga and Sandalwood, ray florets mauve, 20.3.1947, S. L. Everist 2,750 (BRI); Jericho, 3.1946, M. C. Clemens (BRI); Barcoo, 1870, E. Schneider (MEL); about 8 miles S.W. of Yalleroi, sub-shrub, 23.10.1940, L. S. Smith and S. L. Everist 917 (BRI); Tambo 1871, E. Schneider (MEL); between the Barcoo and Roma, 1871, Birch (MEL); Armadilla, 1867, M. Barton (MEL); Charleville, in mulga country, on reddish-brown very sandy loam, *ca.* 1,000 ft.; ray purplish, 19.4.1934, S. T. Blake 5,370 (BRI); Roma, fairly common weed in sandy soil, 25.10.1933, C. T. White, 9570 (BRI); Miles, B. Scortechini (MEL); each of Thargomindah, 1885, Spencer (MEL); Murweh, 9.1916, R. Cameron (BRI); Boatman Station, in red-brown silty clay-loam with Box, rays pale-purple, 18.7.1947, S. L. Everist 3,093 (BRI); 21 miles W. of Bollon, in gutter on clay loam at foot of hard red ridge, rays lilac, 7.8.1946, S. L. Everist 2,603 (BRI); Honeyamah, in heavy grey clay with deep melon-holes, ring-barked Belah, rays lilac, 16.7.1948, S. L. Everist 3,471 (BRI); Ballandool River, 1867, H. W. Looker (MEL); Currawillighi, I. C. Dalton (MEL); Lochnagar, 17.11.1930, A. M. Sutherland (BRI); 30 miles W. of St. George, in *Eucalyptus* forest, on reddish fine sand, *ca.* 600 ft., low bushy dull-green annual up to 6 in., ray purplish to white, 15.3.1936, S. T. Blake 10,791 (BRI); Glenoie, very common in red sandy loam with *Euc. melanophloia*, 7.4.1939, S. L. Everist 1,749 (BRI); N.N.W. of Bungunya, in mallee scrub, *ca.* 800 ft., stem tufted, ascending or oblique, rays light mauve, 26.7.1945, S. T. Blake 15,863 (BRI); Wyaga, 9.1919, C. T. White (BRI); Kindon Station, 54 miles N.N.E. of Goondiwindi, 5.12.1938, L. S. Smith 520A (BRI); Bybera, very common in sandy soil, freely eaten by stock, 2.9.1934, C. T. White 9,722 (BRI); Thulimbah, Granite belt, 2.1934, C. Schindler (BRI); Ballandean,

14.10.1933, C. T. White 9,420 (BRI); Eukey, via Stanthorpe, 11.1944, Goebels (BRI); Stanthorpe, in *Eucalyptus* forest at foot of granite mountain in grit quartzite, 3,000 ft., 11.3.1931, C. E. Hubbard 5,729 (BRI); between Tablinga and Nanango, 6.1912, C. T. White (BRI); hills about Chermiside, 1.1918, C. T. White (BRI); Moreton Bay, 1872, Eaves (MEL); Broadwater, near Brisbane, cleared *Eucalyptus* forest country, on stony slopes, amongst grasses, 5.10.1930, C. E. Hubbard 4,361 (BRI); Brisbane River at St. Lucia moderately common as undergrowth among grass in mixed *Eucalyptus* forest, on Brisbane schist, flowers white, drying off a pale lavender, 6.4.1945, C. T. White 12,645 (BRI).

*New South Wales*: Thirty miles S.W. of Woodenbong on Stanthorpe road, granite sand, 23.11.1946, S. L. Everist and L. J. Webb 1,388 (BRI); Wallangarra, 5.1914, J. L. Boorman (NSW 14,731); near Tenterfield, C. Stuart (MEL); Timbarra, C. Stuart (MEL); Mt. Russell, 20.1.1915, pastures, E. Breakwell (NSW 14,675); 7 miles from Guyra, Inverell road, 18.2.1941, G. L. Davis (NE); Castle Doyle road, 4 m. from Armidale, 3,000 ft., granite, open *Eucalypt* forest, 17.3.1951, G. L. Davis (NE); Wollomombi, cleared grassland, granite, 31.1.1941, C. Davis (NE); Warialda, 5.1905, H. M. Rupp (NSW 13,726); Baradine and Narrabri, 12.1916, G. Burrows (NSW 14,997); Cuttabri, Pilliga scrub, 8.1913, J. L. Boorman (NSW 14,724); Gunnedah, 9.1910, J. L. Boorman (NSW 14,681); Coonabarabran, 9.1916, J. L. Boorman (NSW 14,950); Liverpool Range, J. E. Tenison-Woods (MEL); Rocky hills, Peel Range, 1817, A. Cunningham 335 (MEL); Murrurundi, 5.1902, J. H. Maiden and J. L. Boorman (NSW 14,739); 11 miles on the Dubbo-Mendooran road, rocky hill, 10.8.1944, G. W. Althofer (NSW 14,741); plains near Dubbo, 10.1883, E. Betche (NSW 14,712); Gulgong, 4.1901, J. H. Maiden and J. L. Boorman (NSW 14,700); Mudgee, 1870, Taylor (MEL); Rylstone road, red loam on roadside, 2,500 ft., 22.9.1948, E. F. Constable (NSW 14,707); Paroo River district, 9.1900, E. Betche (NSW 14,720); Wanaaring, 18.9.1939 (NSW 14,717); Bourke, 9.1912, J. L. Boorman (NSW 14,718); between the Bogan and Darling, 1877, L. Morton (MEL); Coolabah, 12.1908, J. H. Maiden and J. L. Boorman (NSW 14,689); Cobar, 22.9.1924, A. Morris (NSW 14,683); Nyngan, 5.1913, J. H. Maiden (NSW 14,695); Duck River, 9.1914, A. A. Hamilton (NSW 14,723); 90 miles E. of Broken Hill, 20.8.1939, I. Pidgeon and J. Vickery (NSW 14,949); Lake Cawndilla, 2.9.1921, MacGillivray (NSW 14,737); Wentworth, Ford (MEL); Euabalong, 5.1906, J. L. Boorman (NSW 14,729); Cargellico, 9.1918, J. L. Boorman (NSW 14,703); Harvey Ranges, Peak Hill, 11.1905, J. L. Boorman (NSW 14,682); Condobolin Station yard, 8.1897, J. H. Maiden (NSW 14,719); Parkes, red loam, 1,035 ft., E. F. Constable (NSW 14,629); Bumberry, 2.10.1916, J. B. Cleland (AD); Bogan Gate, 4.1924, E. H. Ising (NSW 14,685); Cowra, 4.1915, J. Beattie (NSW 14,677); Young, 10.1923, C. M. Western (NSW 14,742); Temora, 9.1915, J. W. Dwyer (NSW 14,732); Barmedman, 29.8.1926, C. S. Sutton (MEL); Beckom, 11.1917, J. L. Boorman (NSW 14,738); Ardlethan, 30.9.1916, R. H. Cabbage (NSW 14,678); Wyalong, 10.1905, J. E. Carne (NSW 14,734); Hay, J. J. Fletcher (NSW 14,721); Deniliquin, 9.1904, J. J. Tadgell (MEL); Brookong, Wagga, 1873, A. Crouch (MEL); Pleasant Hills, 1889, Fischer (MEL); Henty Cemetery Reserve, 18.2.1949, E. J. McBarron (NSW 14,691); Blackheath, 4.1899, J. H. Maiden (NSW 14,715); Valley Heights, Blue Mountains, 7.1899, W. Bauerlen (NSW 14,722); Liverpool, amongst grasses on hill, in forest, 15.4.1931, C. E. Hubbard 8,484 (BRI); Chester Hill, on outskirts of *Leptospermum* scrub, 16.9.1945, M. Tindale (NSW 3,102); Homebush, 5.1887, J. H. Maiden (NSW 14,697); Rookwood, 7.5.1887, J. J. Fletcher (NSW 14,716); Hornsby, 3.1915, W. F. Blakely (NSW 14,679); reclaimed ground, Govt. Domain, Sydney, 10.1902, J. H. Camfield (NSW 14,736); Kogarah, railway embankment, 10.1894, J. H. Camfield (NSW 14,740); Nowra, 1932, P. Monaghan (FAR).

*Victoria*: Mildura, 9.1912, H. B. Williamson (MEL); near Lake Hindmarsh, 10.1892, St. Eloy D'Alton (MEL); Kamarooka, Northern Whipstick, 10.1941, A. J. Tadgell (MEL); Lower Loddon River, R. Thom (MEL); Campaspe River, 10.1875 (MEL); Goulburn River, near Seymour, 27.10.1902; F. M. Reader (MEL); Chiltern, H. B. Williamson (MEL).

*Northern Territory*: Connor's Well, 10.1939, B. A. Dale (NSW 14,708); Glen Edith, mulga scrub, 1894, R. Tate (AD).

*South Australia*: Murray pine scrubs, Lower Murray River, 10.1886, C. French (MEL); Murray River, R. Brown (MEL).

Although it was not possible to examine the type specimen in the preparation of the redescription of this species, the detailed nature of the original description and the excellent plate showing the habit, fruits and florets, leave no doubt as to the identity of the species.

A specimen, accompanied by the collector's label bearing the type data of *C. dilatata* ("Rocky hills, Peel's Range, interior of N.S.W., 1817, Cunningham"), is in the Melbourne Herbarium. It is unfortunate that this specimen bears no fruits, but since it is vegetatively identical with *C. cuneifolia*, Bentham's synonymy (1866) of these two species is accepted.

According to Gray (1861) the fruits of *C. palmata* ("Hunter River, N.S.W.") are "smooth on both sides; pappus of 2-4 scales and 1-2 awns, with sparse recurved barbs towards the apex" and the leaves "cuneate or fan-like, palmate, 3-5 lobed, the lower with winged petioles, tapering basally and slightly auriculate". This description is an exact one of *C. cuneifolia* of which *C. palmata* is now listed as a synonym.

Domin's type specimens of var. *biaristata* ("near Jericho, Q") are also not available in Australia, but as this variety was established on a normal character of the species (i.e., 2 awns on the fruits), it is not upheld by the present writer.

White (1946) described var. *glabrescens* from some Queensland specimens ("Torrens Creek, in Eucalyptus forest, sandy soil near Warrigal swamp, 20.3.1933, C. T. White 8,700") in which the indumentum was more sparse than usual. The degree of development of a character, alone, as the basis for separate status is unsound taxonomic procedure, and consequently this variety is relegated to synonymy.

*C. scabriuscula* var. *lobata* ("Eukey, via Stanthorpe, 11.1944, E. Goebels (BRI)"), although vegetatively identical with *C. cuneifolia*, was excluded from that species by White (1946) on account of the distribution of barbs on the awns. Certainly, those of *C. dentex* are usually localized at the ends of the awns with an almost arrow-head arrangement, and this is seen in the holotype of this variety, but the same condition does occur in *C. cuneifolia*. The second distinguishing character used by White, that of infructescence size, does not hold when a large series of specimens is examined. The variety was based on a single record of two specimens from Eukey, Darling Downs, and is relegated to synonymy within this species.

Variation in the fruits involves primarily the number of awns, which is not always constant even within the same head. The usual condition is for two opposite awns to diverge in the same plane as the flattened face of the fruit and for two broad scales to occupy the intervening region between their bases. Supernumerary awns do not affect the position of the basic pair, and are usually not symmetrically placed. The dimensions of the scales in such fruits depends on the available area, and when two awns are close, the intervening scale may be longer than broad (Text-figs. 17-18).

Vegetative variation is confined to leaf size and, to a lesser extent, leaf shape. Specimens from Pilliga Scrub, Coonabarabran and Warialda, in particular, bear leaves which are 1 cm. or less in length but of typical shape. Since no discontinuity could be found on this character, these small-leaved plants are best regarded as extreme variants.

3. *CALOTIS KEMPEI* F. Muell., *Trans. Proc. Roy. Soc. S. Aust.*, 4 (1881), 112. (Text-figs. 20-23.)

*Type data*: "In the vicinity of the River Finke, MacDonnell Ranges, Rev. N. Kempe."

*Lectotype*, Mission Station, Finke River, 1879, H. Kempe (MEL).

Erect branching glabrous or microscopically glandular perennials up to 39 cm. high, with a long tap root. *Leaves* cauline, up to 3.2 cm. long, 1 cm. broad, oblanceolate, sessile, regularly mucronate-serrate. *Inflorescences* up to 19, about 1.5 cm.



diameter, forming a cymose panicle. *Involucral bracts* 16-21, 4-5-5 mm. long, 1.5-2.1 mm. broad, lanceolate, acuminate, entire, shortly glandular and septate hairy. *Ray florets* about 30, the rays 5 mm. long, 1 mm. broad, yellow. *Receptacle* 1.5 mm. high, 1.2 mm. broad, shallowly pitted. *Fruits* brown, the body 1.5-2 mm. long, 0.7-1 mm. broad, flattened, narrow cuneate, microscopically tuberculate; pappus represented by an apically in-rolled collar one-fourth the length of the body, which may bear a solitary short awn.

*Habitat*: No data available.

*Range*: Central Australia.

*Specimens examined*:

*Northern Territory*: Mission Station, Finke River, 1879, H. Kempe (MEL); Burt's Well, 9.8.1931, J. B. Cleland (JBC); The Goyder, Horn Expedition (AD).

*South Australia*: Mt. Everard, 1882, E. Giles (MEL); Tietkins Creek, Musgrave Ra., 20.7.1914, S. A. White (JMB); 20 miles west of Lambana, Musgrave Ra., 23.7.1914, S. A. White (JMB); Todmorden, 9.4.1950, J. B. Cleland (JBC); Oodnadatta, 11.1914, Staer (NSW 14,873; JMB).

The type series is represented by a number of specimens in the Melbourne Herbarium, from which a lectotype was selected.

Apart from a vegetative resemblance to certain specimens of *C. erinacea*, this species is so distinct from any other that Mueller (1882) suggested it might merit generic status, and provisionally placed it in the section *Anacantharia*. The occasional presence of a single small awn (Text-fig. 21), first observed by Black (1929), justifies its retention within this genus. There is a possibility that the awn is always present but is either deciduous or withers on drying, so that it frequently cannot be found in herbarium specimens.

#### 4. *CALOTIS GLANDULOSA* F. Muell., *Trans. Vict. Inst.* (1855), 129. (Text-figs. 24-27.)

*Type data*: "On dry grassy ridges near the Snowy River and its tributaries, towards Maneroo."

*Lectotype*, "On dry grassy ridges near the Snowy River, towards Maneroo, Dec., 1854, F. Mueller" (MEL).

Glandular, ascending or erect branched perennials up to 32 cm. high, with a woody tap root. *Leaves* cauline, the lower up to 3 cm. long, 8 mm. broad, cuneate in gross outline but distally pinnatifid with 5-7 acute lobes. Upper leaves broadly sessile. *Inflorescences* about 20, 2 cm. diameter, on terminal and axillary peduncles. *Involucral bracts* 12-16, 4.5-6.5 mm. long, 1.8-2.8 mm. broad, ovate-lanceolate, entire and acute. *Ray florets* about 50, 7 mm. long, 1-1.5 mm. broad, blue. *Receptacle* 1.6 mm. broad, 1.3 mm. high, conical, shallowly pitted. *Fruits* reddish-brown, the body cuneate, flattened, papillate, 1.6-2.5 mm. long, 1.2-2.5 mm. broad; awns 4-5 of unequal length, 1.5-5 mm. long, barbed only at the tip and alternating with an equal number of marginally ciliate scales which are longer than broad and almost as long as the body of the fruit.

*Habitat*: Grassland and open forest country at high altitudes.

*Range*: Southern highlands of New South Wales and a single record from near the Blue Mountains.

*Specimens examined*:

*New South Wales*: Duckmaloi, pasture, 2.1935, V. May (NSW 14,672); Cooma, 12.1890, E. Bêche (NSW 14,671); Wollandibby, Jindabyne, 4.1890, J. H. Maiden (NSW 14,673); Berridale, on the Monaro Plains, extends up into the lower forest country of the Kosciusko Plateau, 5.1947, A. B. Costin (MEL); on dry grassy ridges near the Snowy River, towards Maneroo, 12.1854, F. Mueller (MEL); Snowy Mts., 4,000 ft., 1.1890, W. Bauerlen (MEL).

Bentham (1866) listed *Huenefeldia coronopifolia* Walp. as a synonym of this species, but it is not treated as such in this paper since not only are Walpers' specimens

("New Holland") not available in Australia, but the original description\* is so brief and superficial as to be useless from the point of view of recognition. The matter is of some importance since, should Bentham be correct, Walpers' epithet must be given priority and the new combination published. Pending location and examination of Walpers' type specimens the current name is retained.

The type locality is thought to be an incorrect spelling of Monaro, from which district this species has been collected within recent years.

5. *CALOTIS XANTHOSIDEA* Domin, *Biblioth. Bot.*, 89 (1929), 655. (Text-figs. 28-30.)

*Type data*: "Sandstone hills of Darling Range near Jericho,\* Queensland, Domin III, 1910."

Erect branching perennials up to 23 cm. high, with an indumentum of long white septate hairs. *Leaves* cauline, ovate-cuneate to cuneate, serrate, up to 6 cm. long, 3-3 cm. broad, sessile, rather abruptly narrowed proximally and auriculate. *Inflorescences* about 80, 2 cm. diameter, on axillary terminal peduncles. *Involucral bracts* 14-18, 3-3.5 mm. long, 0.6 mm. broad, linear, entire, acuminate, glandular and septate hairy on the outer surface. *Ray florets* 25-28, the rays 9 mm. long, 1.6 mm. broad, white or mauve. *Receptacle* 0.7 mm. broad, 0.5 mm. high, conical, hardly pitted. *Fruits* reddish-brown, the body cuneate, flattened, 1-1.6 mm. long, 0.7-1.1 mm. broad, minutely tuberculate; awns 5-8, 1.5-2 mm. long, rigid, horizontally placed, distal barbs passing proximally into long straight hairs, scales short, alternating with the awns, entire and marginally ciliolate.

*Habitat*: Sandy soil in open forest.

*Range*: Mitchell and Gregory South districts of Queensland.

*Specimens examined*:

*Queensland*: Twenty miles east of Corinda Sta., erect herb on red sandy soil, ray florets white, 7.4.1946, S. L. Everist 2,569 (BRI); near Lochnagar, in *Eucalyptus* forest on fine sand, ca. 1,100 ft., bushy dull green annual of about 6 in., 29.11.1935, S. T. Blake 10,278 (BRI); about 5 miles east of Jericho, tufted prostrate herb with yellow flower heads, 24.10.1940, L. S. Smith and S. L. Everist 982 (BRI; MEL); east of Jericho, in mixed open forest on sand, ca. 1,250 ft., tufted, ascending, ray lilac, 16.7.1934, S. T. Blake 6,827 (BRI); Tenham Sta., 25 miles S.S.E. of Windorah, on stony ridge with *Acacia*, bushy subglaucous annual of ca. 6 in., ray light mauve, 9.6.1936, S. T. Blake 12,033 (BRI).

The redescription of this species was based on a number of specimens from the type locality which agree with the original description and are not referable to any other species.

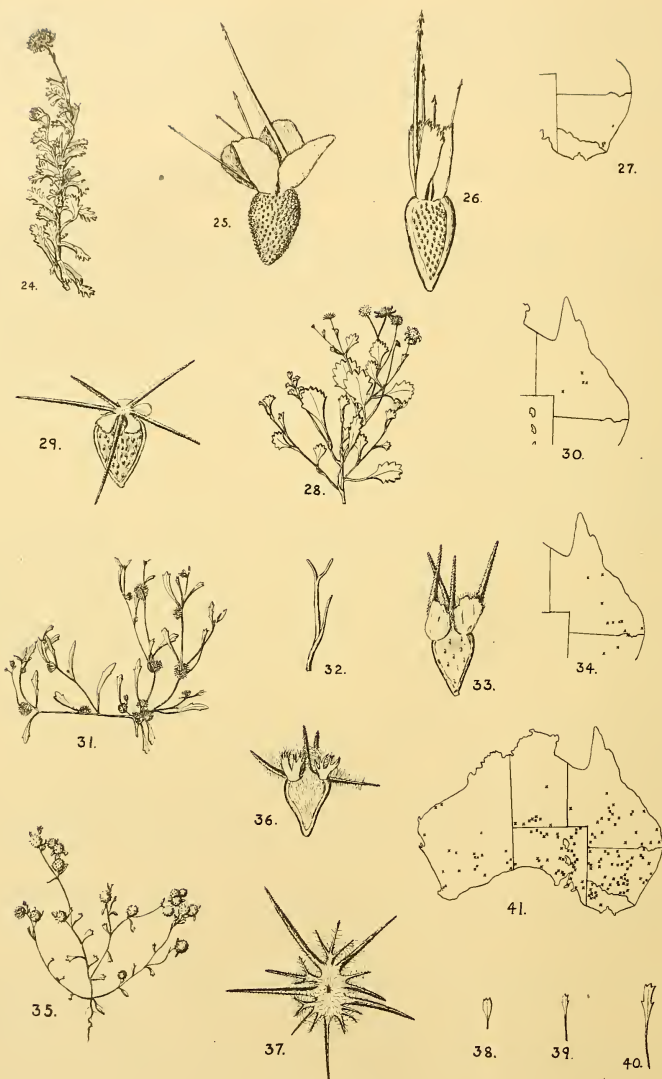
Both Domin (1929) and White (1946) have commented on the resemblance of this species to *C. cuneifolia* in the shape of the leaves, but the fruits are distinct and are not unlike those of *C. squamigera* in the entirely barbed awns and the nature of the scales.

6. *CALOTIS SQUAMIGERA* C. T. White, *Proc. Roy. Soc. Q.*, 57 (1946), 32. (Text-figs. 31-34.)

*Holotype*, Macintyre River, near Queensland border at Goondiwindi, 9.1944, C. T. White 12,621 (BRI).

Branching, more or less septate-hairy, procumbent annuals, up to 21 cm. high. *Cauline leaves* cuneate-spathulate, the lower up to 4 cm. long, 4 mm. broad, distally toothed and tapering into a short petiole. *Radical leaves* present only on young plants, up to 7 cm. long, 6 mm. broad, similar in shape to the cauline leaves of the same plant but with a long slender petiole. *Inflorescences* about 50, 4 mm. diameter, axillary, on very short peduncles so as to appear almost sessile, and each exceeded by a subtending leaf. *Involucral bracts* about 15, 3-3.5 mm. long, 1-1.5 mm. broad, narrow-elliptical, entire, acute, septate-hairy on outer surface. *Ray-florets* about 12, the rays very minute, up to 0.8 mm. long, 0.1 mm. broad, exceeded by the stylar arms. *Disc florets* fertile.

\* "Short bushy erect stem with ascending branches; leaves sessile, linear, pinnatifid, glandular-pilose on both sides; capitula solitary at the apex of almost leafless peduncles.—In New Holland."



Text-figures 24-41.

24-27, *C. glandulosa*.—24, Habit  $\times 0.3$ ; 25-26, Variation in fruits  $\times 6.3$ ; 27, Distribution; 28-30, *C. xanthosoidea*.—28, Habit  $\times 0.3$ ; 29, Fruit  $\times 9$ ; 30, Distribution; 31-34, *C. squamigera*.—31, Habit  $\times 0.3$ ; 32, Ray floret  $\times 15.3$ ; 33, Fruit  $\times 6.3$ ; 34, Distribution; 35-41, *C. hispida*.—35, Habit  $\times 0.3$ ; 36-37, Fruit, lateral and apical views  $\times 6.3$ ; 38-40, Variation in lower cauline leaves  $\times 0.3$ ; 41, Distribution.

*Receptacle* 1.5 mm. broad, slightly convex, septa present between the bases of the florets. *Fruits* reddish-brown, the body 1.7-2.2 mm. long, 1.1-1.3 mm. long, cuneate, flattened, minutely tuberculate; awns 4-5, 1.7-2.5 mm. long, vertical or slightly divaricate, minutely barbed along the whole length, alternating with short entire scales with ciliate margins.

*Habitat*: Grassland and open forest.

*Range*: Well distributed, but not common, throughout inland districts of Queensland, with only two records from Western New South Wales.

*Specimens examined*:

*Queensland*: Charters Towers, weed on racecourse, 6.8.1942, H. Flecker (BRI); Maxwellton, in grassland, ca. 550 ft., shortly creeping, ascending or erect, fls. yellowish, 22.8.1936, S. T. Blake 12,650 (BRI); Blackall, small tufted plant on sandy loam near Barcoo River, leaves and flower heads pale green, 24.8.1935, S. L. Everist 1,210 (BRI); Murweh, Warrego River, 9.1916, R. Cameron (BRI); Mungallala, 8.1913, W. Dunn (NSW 14,860); Bungeworogorai, 25.10.1933, C. T. White 9,532 (BRI); Eight-Mile Plains, near Brisbane, weed of cultivation introduced with sheep manure, 26.10.1930, C. T. White (BRI); NNW. of Gungunya, in brigalow-belah "scrub", compact brown soil, ca. 700 ft., more common in open places, spreading annual, 26.7.1945, S. T. Blake 15,874 (BRI).

*New South Wales*: Macintyre River, near Goondiwindi, 28.9.1944, C. T. White 12,621 (BRI); near Wangan, Pilliga scrub, in pasture, 13.10.1918, J. B. Cleland (AD); Cobar, J. B. Cleland (AD).

This species appears to be centred in western Queensland, and the isolated plants collected elsewhere are probably the result of fruits being distributed attached to the wool of sheep or, according to White, in sheep manure. In this connection, there is an interesting record in the National Herbarium, Sydney, of a well-grown specimen of this species from Galashiels, Scotland, April, 1915, collected by Miss Hayward, who was interested in alien plants appearing in this locality from seeds brought in with imported wool.

As already noted by White (1946), this species is most closely allied to *C. hispidula*, from which he distinguished it by the colour of the fruits and the shape of the alternating scales. To these differences may be added the absence of hairs on the fruits of *C. squamigera*, and the entire or only shallowly lobed scales. In the field, this species can be readily identified by its axillary and solitary inflorescences which are very shortly pedunculate and at the fruiting stage appear sessile. In all the specimens examined there was a single inflorescence at ground level, from immediately below which the branches passed off from the very short main stem.

The ray florets cannot be distinguished in some specimens, due to the microscopic size of the ray which, in dried specimens, has usually shrivelled and disappeared, so that the stylar arms are apparently naked. (Text-fig. 32.)

7. *CALOTIS HISPIDULA* (F. Muell.) F. Muell., *Trans. Vict. Inst.* (1853), 129. (Text-figs. 35-41.)

*Cheiroloma hispidulum* F. Muell., *Linnaea*, 25 (1852), 401.

*Type data*: "In exposed clayey places near Crystal Brook and Cudnaka."

*Lectotype*, "*Cheiroloma* (n.g.) *hispidulum*, Ferd. Mueller, Crystal Brook and Cudnaka, Ferd. Mueller" (MEL).

Prostrate or ascending annuals from 1.5-27 cm. high, with many slender branching stems, and an indumentum of white septate hairs. *Cauline leaves* cuneate and distally 3-5 toothed or occasionally entire, up to 2 cm. long; the uppermost often clustered below the inflorescences. Lower cauline leaves not uncommonly smaller than those in a median position. *Inflorescences* greenish, up to several hundred on a large plant, forming rather dense cymose panicles, each slightly exceeded by the leaves immediately below. *Involucral bracts* 11-14, 3.5-4 mm. long, 1.1-1.4 mm. broad, lanceolate to spatulate, entire, subacute to acute, densely septate hairy on outer surface. *Ray florets* about 10, 0.8-1 mm. long, 0.2 mm. broad, filiform yellow. *Disc florets* fertile. *Receptacle*



0.8-1 mm. broad, 0.5-1 mm. high, conical, with prominent septa between the florets. *Fruits* very dark brown, the body cuneate, flattened, 2-2.5 mm. long, 1.5-2 mm. broad, shortly hairy on each face and woolly apically; awns 5-6, 1.5-2.5 mm. long, rigid, horizontally placed, distally barbed and proximally woolly, alternating with scales which are dissected into 2-8 soft marginally hairy processes.

*Habitat*: Grassland in dry situations on various types of soil.

*Range*: Throughout Australia.

*Specimens examined*:

*Queensland*: Georgina River, 1889, A. Henry (MEL); Hughenden, tufted, prostrate, 14.6.1934, S. T. Blake 6,203 (BRI); Bowen Downs, 1872, C. W. Birch (MEL); north of Ilfracombe, in open grassland on dark brown clay, erect or ascending, rather glaucous annual of 1-2 in., fls. pale greenish-yellow, 3.5.1936, S. T. Blake 11,355 (BRI); between Isis Downs and Portland Downs, prostrate herb, in heavy soils in river channels, 27.5.1936, S. L. Everist and C. T. White 73 (BRI); Blackall, small tufted plant on sandy loam near Barcoo River, leaves and flower heads pale green, 24.8.1935, S. L. Everist 1,210 (BRI); Blackall, common on sandy land and lighter soils throughout the district, 29.8.1935, S. L. Everist 1,349 (BRI); Albilbah Downs, on brown soil near eastern tank, alt. 750 ft., 11.7.1934, S. T. Blake 6,711 (BRI); Minnie Downs, L. Reese (JMB); Barcarolle, Jundah, a winter growing plant, 30.9.1930, F. L. Berney (BRI); Windorah, W. H. Rose (BRI); Mt. Howitt Station, 110 miles west of Eromanga, in open plain on grey silty clay, dense prostrate or ascending annual, 6.7.1936, S. T. Blake 12,004 (BRI); Nockatunga Station, between channels of Wilson River, on loamy sand "claypans", among Chenopodiaceae, 27.6.1936, S. T. Blake 11,830 (BRI); between Stokes Range and Coopers Creek, Wheeler (MEL); Emerald, P. A. O'Shanesy, (MEL); Gindie, 8.1916, C. T. White (BRI); Neerkool Creek, Rockhampton, 1857, E. Bowman (MEL); Gayndah, 8.1913, F. Kenny (BRI); Bungeworgorai, near Roma, very common in sandy soil, 25.10.1933, C. T. White 9,532 (BRI); 20 miles west of Bollon, in gutter on clay loam at foot of hard clay ridge, 7.8.1946, S. L. Everist (BRI); NNW of Bungunya, in Brigalow-Belah "scrub", compact brown soil, ca. 700 ft., more common in open places, 26.7.1945, S. T. Blake, 15,874 (BRI); Toowoomba 11.1916, G. Searle and Sons (BRI); near Brisbane, J. Lauterer (BRI).

*New South Wales*: Macintyre River, near Goondiwindi, 28.9.1944, C. T. White 12,620 (BRI); Gravesend, 5.1914, W. Carne (NSW 14,808); Bingara and Warialda, 9.1929, F. A. Rodway (FAR); Tamworth, 9.9.1938, E. R. Johnston (KI); Pilliga, 10.1932, H. M. R. Rupp (NSW 14,810); Gilgandra, 9.1915, J. D. Simon (NSW 14,819); Castlereagh River, Woolls (MEL); Narromine, 9.1898, J. H. Maiden (NSW 14,832); Nyngan, on railway line, abundant (MEL); Nyngan, plains, prostrate plant, 11.9.1947, E. F. Constable (NSW 14,461); Boppy Mount, 6.1903, W. Bauerlen (NSW 14,845); Cobar, 1883, H. Andrae (MEL); Bourke to Cobar, 27.8.1926, C. S. Sutton (MEL); between the Bogan and Darling, 1877, L. Morton (MEL); Bourke district, 8.1896, J. H. Maiden (NSW 14,816); Warrego River, 9.1885, E. Bette (NSW 14,830); Wanaaring-Urisino, 10.1912, J. L. Boorman (NSW 14,831); Paroo River district, 9.1900, E. Bette (NSW 14,817); White Cliffs, 7.1906, E. P. O'Reilly (NSW 14,977); Tarella, 8.1887, W. Bauerlen (MEL); Silvertown, 24.8.1939, I. Pidgeon and J. Vickery (NSW 14,964); Broken Hill, 9.1918, E. C. Andrews (NSW 14,834); Stephen's Creek, 12.8.1928, A. Morris (MEL); Campbell's Creek, 4.8.1920, A. Morris (NSW 14,833); Broken Hill to Torrawangee, 8.1893, H. Deane (NSW 14,827); Wilcannia, 9.1884, D. A. Porter (MEL); 84 miles east of Wilcannia, 26.8.1939, I. Pidgeon and J. Vickery (NSW 14,836); Mossgiel, 1855, J. Bruckner (MEL); between the Darling and the Lachlan, 1877, Burkitt (MEL); between the upper Bogan and Lachlan, L. Morton (MEL); Lachlan River, L. Morton (MEL); Trundle, 1912, E. Breakwell (NSW 14,844); Lake Cargellico, 10.1906, J. L. Boorman (NSW 14,840); Tullibigeal, 20.9.1915, J. W. Dwyer (NSW 14,837); Ardlethan, 1.10.1916, R. H. Cambage (NSW 14,835); Temora, 9.1915, J. W. Dwyer (NSW 14,836); Scenic Hill, Griffith, 17.9.1938, D. O. Cross (NSW 14,822); Griffith, on dry hills, 7.1928, W. F. Blakely and D. W. C. Shiress (NSW 14,811); Yanco, 6.10.1912, J. B. Cleland (AD); Zara, via Hay, 9.1903, E. Officer (NSW 14,965); Wanganella, 1885, Kuentz (MEL); Hay, 22.9.1889, J. J.

Fletcher (NSW 14,828); Murrumbidgee River, 9.1878, F. Mueller (MEL); Bahranald, 1878, Lucas (MEL); Edwards River, 10.1875, F. Mueller (MEL); junction of Darling and Murray Rivers, 1889, Holding (MEL); Tarcutta, 1.10.1947, F. J. Jeffery (NSW 14,823); Cemetery Reserve, Henty, in red sandy loam of more sparse grassland, in clumps, 2.9.1949, E. J. McBarron (NSW 14,824); Belmont, 9.1910, J. L. Boorman (NSW 14,963); Cowan, on railway line, ray flowers yellow, 10.1921, W. F. Blakely (NSW 14,813); between Richmond and Blacktown, grassland, 30.9.1910, C. T. Musson (NSW 14,843); Parramatta, 1887, Woolls (MEL).

*Victoria:* Mildura, 5.9.1912, H. B. Williamson (MEL); Wimmera, 1891, J. P. Eckert (MEL); Birchip, 11.9.1927, C. S. Sutton (MEL); Dumosa Road, near Wycheproof, 8.1918, W. W. Watts (NSW 14,850); Jeparit, 14.10.1912, W. R. Baker (MEL); Mallee, near Nhill, 1884, St. Eloy D'Alton (MEL); Antwerp, 10.905, C. S. Sutton (MEL); near Dimboola, F. Reader (MEL); Minyip, 1890, J. P. Eckert (MEL); Lake Boga, 11.1903, H. Bird (MEL); Skipton, W. Whan (MEL).

*Northern Territory:* Darwin, sheep paddock, herb on rocky hills, 7.1922, C. E. F. Allen (NSW 14,859); Tennant's Creek, 12.1896, Agric. Bureau, S.A. (NSW 14,853); near Hugh River, Macdonnell Ranges, 19.8.1929, J. B. Cleland (JBC); Hermannsburg, 9.8.1929, J. B. Cleland (JBC); Tempe Downs, 1889, Thornton (MEL); end of Gill's Range, 8.5.1894, R. Tate (AD); Finke River, 1879, H. Kempe (MEL); Charlotte Waters, 1875, C. Giles (MEL); 50 miles N.E. of Ayer's Rock, 9.6.1935, J. B. Cleland (JBC); N.W. of Petermann Range, 7.1926, H. Basedow (P).

*South Australia:* 2 miles west of Eriwanjawanja, Musgrave-Mann Ranges, 21.6.1933, Tindale and Hackett (AD); Ernabella, in low-lying hard soils, 1.7.1943, L. B. Young (MEL); halfway between Moorilyanna and Ernabella, 7.8.1933, J. B. Cleland (JBC); Everard Ranges, 11.4.1950, J. B. Cleland (JBC); Alberga Creek, 1.7.1920, H.W.A. (JMB); 20 miles west of Oodnadatta, 5.8.1933, J. B. Cleland (JBC); Minnie Downs, L. Reese (JMB); Diamantina, 8.1930, Morgan (JBC); flood plain of the Diamantina, Goyder's Lagoon, 14.8.1934, J. B. Cleland (JBC); Warburton River (AD); Lake Eyre, 9.1903, Baldwin Spencer (NSW 14,858); Kopperamanna, 7.10.1916, S. A. White (JMB); Beresford, 21.9.1945, J. B. Cleland (JBC); Finnis Springs, beyond Hergott, 5.9.1916, F. D. Warren (JMB); 5 miles north of Marree, 8.1931, J. B. Cleland (JBC); Marree, 5.8.1932, J. B. Cleland (JBC); Mt. Lyndhurst, 8.1899, M. Koch (AD); Mt. Flinders Gorge, Flinders Range, 30.5.1937, J. B. Cleland (JBC); between Flinders Range and Lake Torrens, T. P. Richards (MEL); Moolooloo, small prostrate plant, 29.9.1918 (JMB); Parachilna, 20.8.1921, J. B. Cleland (JBC); Wilpena Pound, 17.11.1881 (AD); between Wilpena and Oraparinna, 1.12.1930, J. B. Cleland (JBC); Koonamore Vegetation Reserve, 15.2.1930, T. B. Paltridge (AD); Gordon, 11.10.1917, J. M. Black (JMB); Woolshed Flat, near Quorn, 12.1914, J. Mills (JMB); Warren's Gorge, near Quorn, 1.10.1916, J. B. Cleland (JMB); Crystal Brook, F. Mueller (MEL); Cudnaka, 10.1851, F. Mueller (MEL); Yorke Penin., 1879, Tepper (MEL); Kinchana, 8.11.1924, 17.9.1927, J. B. Cleland (JBC); Arcoona, 18.9.1927, B. J. Murray (AD); in crabhole, tablelands, Andamooka, 4.11.1929, J. B. Cleland (JBC); 7 miles east of Iron Knob, 25.8.1928, J. B. Cleland (JBC); Middleback Sta., 5.11.1930, J. B. Cleland (JBC); between Spencer's Gulf and Mt. Ella, C. Giles (MEL); Gawler Ranges, Sullivan (MEL); Wudinna, 1941, C. W. Johns, Tarcoola, 19.9.1920, J. M. Black (JMB); Ooldea Soak, 17.8.1939, J. B. Cleland (JMB; JBC); Pidinga, 6.1880 (AD); Fowler's Bay, 10.1907, T. Brown (NSW 14,854); Hughes, 6.9.1920, E. H. Ising (BRI; MEL; NSW 14,848); Nullarbor Plains, 1891, J. D. Batt (MEL).

*Western Australia:* Port Hedland, 7.1906, W. V. Fitzgerald (P); Gascoyne River, near Jimta Jimta, common in sand or clay, 20.9.1941, C. A. Gardner 6,050 (P); Champion Bay, Walcott (MEL); Parker Ranges, 1892, E. Merrill (MEL); Cue, 9.1903, W. V. Fitzgerald (NSW 14,853); Sandstone, 8.1937, N. Knip (P); Mt. Fouracre, N.W. of Leonora, 8.1931, W. E. Blackall 341 (P); Mt. Fouracre, 28.7.1931, C. A. Gardner 2,430 (P); Glenorn Station, Malcolm, 8.1938, N. T. Burbidge (P); Laverton, 9.1909, J. H. Maiden (NSW 14,988); Victoria Desert, Camp 53, 15.9.1891, R. Helms (MEL); York, 19.10.1889, M. Heal (MEL); sources of the Swan River, 1889, A. Eaton (MEL); Yilgarn, 1892, Merrill (MEL); Kalgoorlie, 7.10.1914, C. H. Ostenfeld (P); Boulder,

s.1898, W. V. Fitzgerald (NSW 14,852); Nullarbor Plains, 1891, J. D. Batt (MEL); 100 miles N. of Eucla, J. D. Batt (MEL); Eucla, J. D. Batt (MEL).

The genus *Cheiroloma* was described by Mueller (1852) from specimens collected by himself at Cudnaka and Crystal Brook and which he named *Cheiroloma hispidulum*. In 1855, however, he incorporated this monotypic genus in *Calotis* with the note "the genus *Cheiroloma* may be referred as a fifth section to this genus" (i.e. *Calotis*).

The type series consists of several well preserved specimens in the Melbourne Herbarium from which a lectotype was selected.

Variation in the large series examined was found to be slight and was chiefly confined to the size of the plants. While the mean length of the branches was about 10 cm., dwarf fruiting specimens of 1.5-2.5 cm. in height were seen from all States, and in these the infructescences were hardly smaller than those of normal-sized plants. Plants in which the leaves were all entire were seen only from the Eucla and Nullarbor Plains areas.

Variation in leaf size was sometimes marked, but appeared to have no taxonomic significance.

The ray florets were always minute and often difficult to find in dried specimens owing to withering of the ligule, and it is chiefly the disc florets which give the yellow or yellowish-green colour to the inflorescences.

The number of infructescences varied with the size of the plant, some bearing many hundreds in tight cymose panicles.

As already noted, the points of resemblance between this species and *C. squamigera* are so many that close relationship is reasonably assumed. Comparison of vegetative features is most satisfactory when both species are growing together in the same situation and such was the case in a folder of specimens from Blackall. In these, *C. hispidula* possessed many slender branching stems arising from the base, with few or no radical leaves, whereas those of *C. squamigera* bore a solitary inflorescence at ground level from below which branches and radical leaves were given off. This distinction was also observed in specimens from other localities and is of use in field identification. Differences in the fruits of the two species have already been discussed in connection with *C. squamigera*.

8. *CALOTIS ERINACEA* Steetz in Lehmann, *Pl. Preiss.* (1845), 424. (Text-figs. 42-56.)

*C. erinacea* var. *parviflora* Benth., *Fl. Aust.*, III (1866), 503; *C. erinacea* var. *biaristata* J. M. Black, *Fl. S.Aust.* (1929), 590.

*Type data*: "Only in rather muddy situations, Hay, November, 1840. Herb. Preiss No. 2427 (Drummond)".

*Lectotype*, "New Holland (Swan River Colony) in rather muddy situations, Hay, coll. Preiss (Herb. Preiss No. 2427), received 1843" (MEL).

Much branched erect or straggling glabrous perennials, up to 80 cm. high. *Leaves* cauline, sessile, the lower linear to broad-linear or linear-cuneate, occasionally elliptical, acutely toothed from the base or only distally, rarely entire, up to 6 cm. long, 7 mm. broad. *Upper leaves* acute or acuminate, usually entire. *Inflorescences* up to 70, 1.5-1.7 mm. diameter. *Involucral bracts* 10-22, 2.5-4.5 mm. long, 0.8-2.5 mm. broad, lanceolate to broad-elliptical, entire or microscopically serrulate, obtuse to subacute, glabrous. *Ray florets* 24-50, the rays 5-5.6 mm. long, 1.5-1.7 mm. broad, yellow. *Receptacle* hemispherical to conical, 1-2 mm. broad, 1-2 mm. high, with membranous septa between the florets produced into scale-like structures. *Fruits* light to dark brown, the body flattened and enclosed apically by the expanded bases of the awns forming a collar; exposed portion of body cuneate, 1.5-3 mm. long, 1.6-2.4 mm. broad. Awns commonly 2-4 or 7-9, barbed only distally or along their whole length, 0.5-3.5 mm. long, equal in length when only 2 or 4 present, otherwise variable.

*Habitat*: Sandy soil in low rainfall areas.

*Range*: Throughout Central and South Australia, extending into the western districts of Queensland, New South Wales and Victoria; south-west division of Western Australia.



*Specimens examined:*

*Queensland:* Between Tambo and Blackall, plentiful on sand ridges, 2-3 ft. high, 9.9.1937, L. J. Brass and C. T. White 29 (BRI); Tambo, densely branched subshrub, common in large patches on sandy hillside north of the town, florets yellow, 9.12.1935, S. L. Everist 1,452 (BRI); Currawilla, on deep loose red-brown sandhill, shrub about 2 ft., with numerous spreading intricately branched stems, leaves and stems dark green, with powerful smell of *Eugenia uniflora*, 15.6.1949, S. L. Everist 4,017 (BRI); Arrabury, 25.5.1924, J. B. Cleland (JBC); near Kyabra, common, sandhills, 17.1.1937, S. L. Everist and L. S. Smith 79 (BRI); Mt. Howitt Sta., 80 miles west of Eromanga, on drift sand on lower part of sandhill, bushy deep green shrub of about 2 ft., 4.7.1936, S. T. Blake 11,925 (BRI); Charleville, in open places on sand, ca. 1000 ft., bushy, 2-3 ft. high, 4.4.1936, S. T. Blake 11,015 (BRI); Yappunya, near Thargomindah, 1885, Spencer (MEL); Offham, common on sand ridges, subwoody perennial, 28.3.1941, C. T. White 11,826 (BRI); Cunnamulla, on sand in cemetery enclosure, ca. 600 ft., dense bushy perennial, 29.4.1934, S. T. Blake 5,611 (BRI); Gilruth Plains, 17.9.1938, S. L. Everist 1,632 (BRI); between Stokes Range and Cooper's Creek, Wheeler (NSW 14,611; MEL); Wilson River, 4.9.1923, W. MacGillivray (BRI).

*New South Wales:* Grey Ranges (MEL); near Barrier Range, sand ridges, 19.8.1891, R. Helms (AD); 60 miles from Wentworth, 20.8.1946, J. Vickery (NSW 2,033); Zara, via Hay, 12.1913, E. Officer (NSW 14,995); Conargo, 19.12.1906, A. G. Mayne (NSW 14,612); Deniliquin (NSW 14,970); Mathoura, sand ridges, 5.1947, J. F. Feagan (NSW 14,616); Tocumwal, 9.1891 (NSW 14,613).

*Victoria:* Ouyen, 30.3.1911, G. McIntyre (MEL); Cow Plain, 1895, St. Eloy D'Alton (MEL); Lake Albacutya, 10.1907, C. S. Sutton (MEL); Hopetoun, 10.1897, Brymer (MEL); Echuca (MEL).

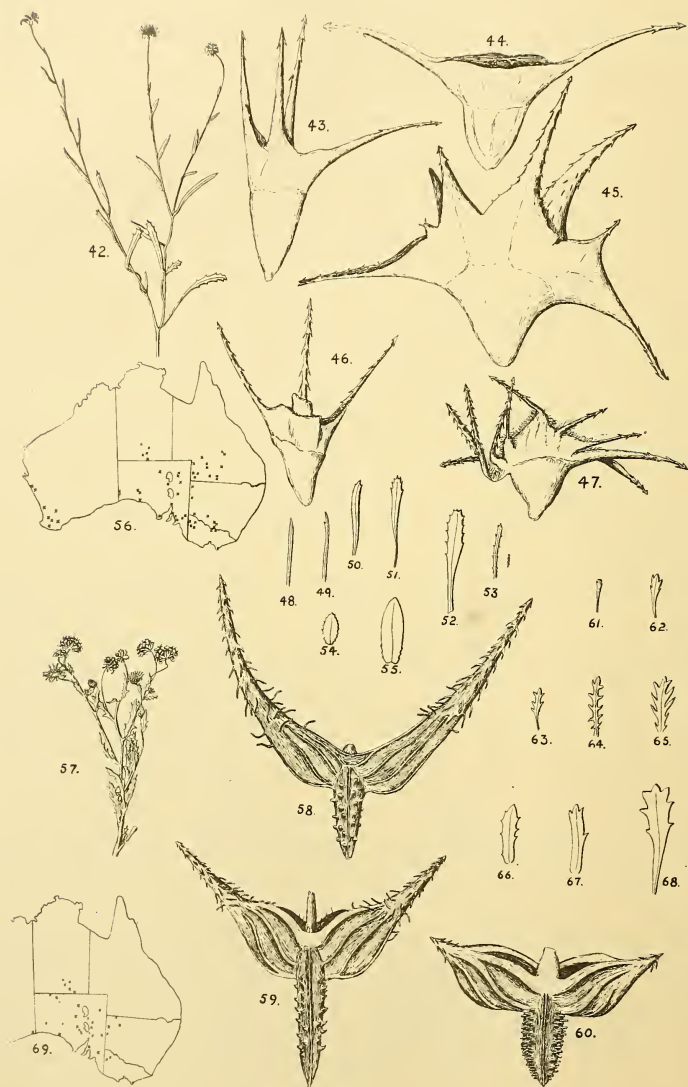
*Northern Territory:* Macdonnell Ranges, 1894, sand hills, subshrubby, 3 ft., R. Tate (AD); Alice Springs, 28.9.1939, B. A. Dale (NSW 14,609); Finke River, 8.8.1931, J. B. Cleland (JBC).

*South Australia:* Between Flinders Range and Charlotte Waters, 1885, H. Kempe (MEL); Cooper's Creek, 10.1920, W. MacGillivray (NSW 14,608); Warrina, 4.1891, R. Helms (AD); Stuart's Creek (MEL); Hamilton Bore, 7.1.1927, J. B. Cleland (JBC); Port Augusta, 1885, A. Richards (MEL); Port Augusta, 1.9.1941, J. B. Cleland (JBC); northern part of Yorke's Penin., 1869, Salmon (MEL); Pinery, Port River, 1.10.1927, J. B. Cleland (JBC); Holdfast Bay and Port Adelaide, F. Mueller (MEL); Berri, 1.1921, J. B. Cleland (JBC); Loxton, 21.8.1924, J. B. Cleland (JBC); River Murray Plain, 5.1.1884 (AD); near Spencer's Gulf, 1881, Lattorf (MEL); Boston Point, F. Mueller (MEL); north of Fowler's Bay, 1875, E. Giles (MEL); Pidinga, 1880, Richards (MEL); Ooldea, 11.9.1920, E. H. Ising (MEL; BRI; NSW 14,617); Ooldea Soak, 5.11.1934, N. B. Tindale (AD).

*Western Australia:* Greenough Flat, C. Gray (MEL); Moore River, Mogumbar, 10.1903, W. V. Fitzgerald (NSW 14,614); Wickepin, 7.1915, W. J. Petticrew (P); Lake Wagin, 1890, M. Cronin (MEL); Stirling Range, 11.1881, J. Forrest (MEL); Gordon River, Oldfield (MEL); New Holland (Swan River Colony) in rather muddy situations, Hay, Preiss No. 2,427 (MEL).

The two type specimens from which the lectotype was selected are accompanied by an envelope of fruits, and attached to a herbarium sheet bearing the determination "*Calotis erinacea nobis*" and locality data in Steetz's handwriting, the date "1843" referring to receipt of the specimens by Steetz, and not to their collection. Their leaves are, unfortunately, rather fragmentary, but according to Steetz (1845) they are "sessile, slightly stem-clasping, linear-lanceolate or linear, acute, with a single vein which is prominent on the lower surface, entire or rarely with a single deep tooth, tapering distally, the lower ones 1-1½ inches, the upper shorter, narrower and more sparse". The only specimens examined by the present writer in which all the leaves were entire were also from Western Australia (Lake Wagin and Gordon River), which suggests that this condition is confined to the western portion of the range. In the eastern States it is quite common for only the lower leaves to be toothed and a fragment





Text-figures 42-69.

42-56, *C. erinacea*.—42, Habit  $\times 0.3$ ; 43-47, Variation in fruits  $\times 6.3$ ; 48-55, Variation in lower cauline leaves  $\times 0.3$ ; 56, Distribution; 57-69, *C. cymbacantha*.—57, Habit  $\times 0.3$ ; 58-60, Variation in fruits  $\times 9$ ; 61-68, Variation in lower cauline leaves  $\times 0.3$ ; 69, Distribution.

from the upper portion of such a plant gives an incorrect impression of the type of leaves present.

Leaf shape varies little throughout the range except for the occurrence of ovoid, almost stem-clasping, leaves on certain specimens from Queensland (Arrabury, Currawilla, Tambo, Kyabra) and South Australia (Eudunga, Hamilton Bore, Andado, Pidinga). This character, unsupported by others, was not considered sufficient to justify separate taxonomic status.

The fruits of this species are remarkable in their variability not only between those of different plants (Text-figs. 43-47), but within the same infructescence. When only two awns are present they are opposite, divaricate in the same plane as the flattened body of the fruit, and the united awn-bases form an entire and relatively deep collar-like structure. The presence of a third awn intermediate between the basic pair is a common variation. When four awns are present, as in the type series, they are equidistant from each other, and the junction of their expanded bases is marked by an indentation. An interesting series of fruits was seen in an infructescence from Erldurda in which some bore 2 or 3 awns and an entire collar, and in others the collar was regularly dissected into short projections between the three major awns. A further development of this condition was shown in specimens from Charleville, in the fruits of which there were four major awns, two of medium length, and three or four short acute projections of the collar with 2-5 barbs at their tips. An evolutionary series can be traced from the 2-awned condition to the 3-, 4- and more-awned state by the development of supernumeraries between the major awns. In their evolution, the supernumeraries progress from mere lobes of the collar, to barbed lobes, then to small but definite awns, and finally to the climax condition seen from a number of localities, in which 7-9 awns of approximately equal length are present and the collar lobed accordingly. It was on such fruits that Bentham (1866) described var. *parviflora* ("Durandoo, Victorian Expedition") for which a lectotype was selected but the variety was not confirmed since it appears to represent merely a variational peak.

On the basis of awn number, plants fall into two groups—those in which 2, 3, 4 or occasionally 5 awns are present, and those with 7, 8, 9 or, rarely, more. All Western Australian specimens belong to the first group, but in other States their occurrence is equal and both are found over the same range. Further collecting may well produce specimens which bridge this apparent discontinuity, and in view of the variation in awn number in the same infructescence, varieties based on this character alone are not upheld.

Bentham (1866) stated: "*Huenefeldia angustifolia* Walp. in *Linnaea*, XIV, 506, which I have not seen, is, from the description, most probably this species." Unfortunately Walpers' specimens have not been traced and the original description\* conveys little idea of the plant in question. Should Bentham be correct in his supposition, Walpers' epithet must take priority over that of Steetz, but until such time as the specimens are located and examined the latter is retained.

9. *CALOTIS CYMBACANTHA* F. Muell., *Linnaea*, 25 (1852), 400. (Text-figs. 57-69.)

*C. cymbacantha* F. Muell., var. *pumila* Benth., *Fl. Aust.*, 3 (1866), 502.

*Type data*: "On barren slopes near Crystal Brook."

*Lectotype*, "On barren slopes near Crystal Brook, 10.1851, F. Mueller" (MEL).

Erect branching herbs up to 40 cm. in height, with a septate-hairy indumentum. *Radical leaves* 6-9 cm. long, spatulate, acutely toothed distally, tapering proximally into a long petiole, but only present on young plants. *Cauline leaves* up to 6.6 cm. long, sessile, broad-linear to spatulate in general outline, either with coarse teeth which are evenly distributed or distal in position or leaves may be pinnatifid to pinnatipartite. *Inflorescences* up to 60, 1.5-2 cm. diameter. *Involucral bracts* 15-20, 3.8-5 mm. long, narrow-elliptical, entire, acute to acuminate, densely septate-hairy on outer surface. *Ray florets* 18-30, the rays 4.6-5 mm. long, 1.2-1.5 mm. broad, yellow. *Receptacle*

\* "Much-branched bush; branches erect, angular; leaves linear-lanceolate, entire, hardly pubescent; inflorescences terminal, solitary—growing in New Holland."

1.3–2 mm. broad, 0.6–1.5 mm. high, hemispherical, with a honeycombed appearance due to ciliate septa between the bases of the florets. *Fruits* brown, the exposed portion of the body cuneate, flattened, tuberculate on each face, 2.0–2.8 mm. long. Distal quarter to third of body enclosed in a boat-shaped structure formed by the united bases of the two rigid divaricate awns which are placed at right angles to the flattened face of the fruit. Awns 1.7–6 mm. long, bearing distally a number of backwardly directed barbs which are represented proximally by white unicellular hairs of the same length.

*Habitat*: No data available.

*Range*: Central and South Australia, extending into western New South Wales and the Wimmera district of Victoria.

*Specimens examined*:

*New South Wales*: Queensland border north and a little west of Broken Hill, 4.1917, MacGillivray (NSW 14,605; AD); Cobham Lake, 1887, W. Bauerlen (NSW 14,602; MEL); Barrier Range, 1889, Irvine (MEL); near Silverton, 7.1889, Irvine (MEL); Burke's Cave, Darling River, 1.8.1893, Tepper (MEL); Darling River, Dallachy (MEL).

*Victoria*: Murray River, F. Mueller (MEL); Cocamba to Ouyen, 9.1921, H. B. Williamson (MEL); Underpool, 9.1918, J. Malone (MEL).

*Northern Territory*: Ooraminna Pass (AD); Deep Well, 25.8.1931, J. B. Cleland (JBC); the Goyder, 1894, R. Tate (AD; NSW 14,597); between Youldeh and Charlotte Waters, E. Giles (MEL); south of Charlotte Waters, 9.1885, H. Kempe (MEL); about 30–80 miles east of Ernabella, 23.9.1945, J. B. Cleland (JBC); Ernabella, 13.7.1943, L. B. Young (MEL); half-way between Morrilyan and Ernabella; 7.8.1933, J. B. Cleland (JBC); between Ernabella and Echo Hill, 20.8.1933, J. B. Cleland (JBC); border of Northern Territory and South Australia, 7.1926, H. Basedow (NSW 14,598).

*South Australia*: Warrina, 1890, Richards (MEL); Strzelecki (AD); Stuart Range, C. French (MEL); N. of Marree, 26.8.1931, J. B. Cleland (JBC); Mt. Lyndhurst, 8.1898, M. Koch (AD; MEL; NSW 14,601); Bitter Well, Coondambo, 28.10.1929, J. B. Cleland (JBC); Parachilna, 20.8.1921, J. B. Cleland (JBC); Arcoona, west of Lake Torrens, sand, 2.8.1927, B. J. Murray (AD); south of Bookaloo, 5.11.1929, J. B. Cleland (JBC); between Flinders Range and Lake Torrens, T. P. Richards (MEL); Koonamore Vegetation Reserve, 31.7.1928, T. B. Paltridge (AD); Mingary, 14.8.1921, A. Morris (NSW 14,604; BRI); 25 miles north of Port Augusta, 28.10.1939, J. B. Cleland (JBC); Port Augusta, A. Richards (MEL); Spencer's Gulf, 1878, Felstead (MEL); towards Spencer's Gulf, Warburton (MEL); in clivis arenosis prope Crystal Brook, 10.1851, F. Mueller (MEL); Mantung district, 18.8.1924, J. B. Cleland (JBC); Hundred of Mantung, 1.1911, W. Gill (NSW 14,600); Wynbring, 20.9.1920, E. H. Ising (NSW 14,603); Ooldea (AD); Fowler's Bay, 10.1907, T. Brown (NSW 14,599).

*Western Australia*: Eucla, 1877, A. Richards (MEL).

Vegetative variation concerns the degree of dissection of the leaves and the amount of indumentum on stem and leaves. The type specimens have pinnatifid cauline leaves, becoming toothed and smaller on the upper parts of the plant, and the awns of the fruits are 2.5–3 mm. long, with the barbed portion equal in length to the expanded base.

Bentham (1866) described var. *pumila* on material collected by Dallachy from "the Darling River to Cooper's Creek", the fruits of which were slightly different from those of the type series in that their awns bore more barbs and their thin distal portions were longer. Measurement of the awns of all specimens examined by the present writer showed continuous variation from those of 6 mm. to the other extreme where they were represented by little more than the expanded bases (Text-figs. 58–60). These bases differed little in size throughout the series, and variation in awn length involved only the thin distal portion. Although a haptotype was selected, var. *pumila* is not regarded as representing a distinct population to the parent species.

The longevity of this species remains still to be established. Bentham (1866), following Mueller (1852), stated "apparently perennial", and for his var. *pumila*, "flowering the first year so as to appear annual". Black (1929), on the other hand, stated "probably always annual".

10. *Calotis* LAPPULACEA Benth., *Enum. Pl. Hueg.* (1837), 60. (Text-figs. 70-79.)

*C. microphylla* Benth. in *Enum. Pl. Hueg.* (1837), 60; *C. polyseta* Sond., *Linnaea*.

- 25 (1852), 470; *C. suffruticosa* Domin., *Biblioth. Bot.*, 89 (1929), 655.

*Type data*: "Ferd. Bauer."

*Haptotype*, Australian Journey, 1802-5, R. Brown (MEL).

Much branched leafy perennials up to 47 cm. high, more or less septate-hairy all over, woody at the base with a thick tap root. *Radical leaves* present only on young plants, up to 6 cm. long, 8 mm. broad, cuneate, toothed or pinnatifid. *Cauline leaves* linear and entire or acutely toothed to pinnatifid, sessile, up to 2.5 cm. long, 4 mm. broad. *Inflorescences* over 200 on an established plant, 1.7-8 mm. diameter. *Involucral bracts* 14-22, 2-3 mm. long, 0.5-1.1 mm. broad, obtuse to subacute, linear, entire, sparsely hairy with ciliate margins. *Ray florets* 44-60, the rays 2.5-3.5 mm. long, 0.5-0.7 mm. broad, yellow. *Receptacle* up to 1.2 mm. broad, 0.5 mm. high, truncate-conical with scale-like septa between the bases of the florets. *Fruits* light to dark brown, the body cuneate, flattened, minutely tuberculate, glabrous, 1.2-1.6 mm. long, 1-1.1 mm. broad; two erect or slightly diverging major awns pass off at right angles to the flattened face, and equal to or slightly exceed the body in length. Secondary awns are almost horizontal in position and seldom exceed 0.7 mm. in length; those facing the periphery of the capitulum form a group of 3-6, which are basally united and give the fruit a lipped appearance when seen from above; the opposite corner of the fruit summit is occupied by a single awn, and occasionally short supernumeraries are also present. All awns are barbed distally and bear septate hairs at the base.

*Habitat*: On various types of soil in open forest and cleared land.

*Range*: Widely spread throughout the eastern States with an occasional record in South Australia and Western Australia.

*Specimens examined*:

*Queensland*: Burdekin River, Suttor (MEL); Charters Towers (BRI); Oakley, on sparsely timbered low sandy ridge, ca. 600 ft., stems numerous, tufted, spreading to erect, ca. 6 in., 2.6.1936, S. T. Blake 11,649 (BRI); near Mueller River, 1881, C. W. Birch (MEL); Dunrobin, 1890, M. Walker (MEL); Jericho, 3.1946, M. S. Clemens (BRI); Yalleroi, in mixed open forest on reddish sand, ca. 1160 ft., 15.7.1934, S. T. Blake 6,774 (BRI); Blackall, very common on sandy aerodrome, 24.8.1935, S. L. Everist 1,230 (BRI); Peak Downs, G. Burkitt (MEL); Emerald, on open sandy ground, ca. 600 ft., fls. bright yellow, 19.7.1934, S. T. Blake 6,915 (BRI); Comet, in sandy soil, open *Eucalyptus* forest country beside railway trucking yards, 3.4.1946, S. L. Everist (BRI); Springsure, 1870, Wirth (MEL); Expedition Range, 1878, Thozet (MEL); Duaringa, 3.1909, J. H. Maiden (NSW 14,747); Canal Creek, 1882, Hartmann (MEL); Rockhampton, scrubby open places, P. O'Shanesy (MEL); Marmon, 3.1920, W. D. Francis (BRI); Gladstone, A. Dietrich (MEL); Mt. Perry, 6.1929, C. S. Sutton (MEL); Gympie, F. H. Kenny (BRI); Boatman Station, in red-brown fine sandy loam with ringbarked Box and low mulga, shady situation, 21.3.1947, S. L. Everist (BRI); between Westgate and Myendetta, in railway enclosure, ca. 950 ft., 26.4.1934, S. T. Blake 5,526 (BRI); Mungallala, 8.1913, W. Dunn (NSW 14,754); Wandoo, in open *Eucalyptus populifolia* forest and *Aristida* sp. on heavy soil, about 900 ft., 5.11.1930, C. E. Hubbard 4,969 (BRI); Bungewin, 25.10.1933, C. T. White 9,535 (BRI); 21 miles west of Bollon, on clay loam at foot of hard red ridge, prostrate herb, 7.8.1946, S. L. Everist 2,599 (BRI); Roma to Surat, C. S. Sutton (MEL); Surat, 1892, H. Wehl (MEL); Condamine River (MEL); Dalby, 4.1916, C. T. White (BRI); Toowoomba, 1886, F. A. Hood (MEL); 2 miles south of Pittsworth, in shallow chocolate clay loam, basal, in open parkland with *Eucalyptus melliodora*, *Stipa* spp., S. L. Everist and L. J. Webb 1,236 (BRI); Moreton Bay, C. Stuart (MEL); Ipswich, 12.1908, T. F. Hall (BRI); near Laidley, on railway bank amongst grasses, in sandy loam, ca. 335 ft., 5.7.1930, C. E. Hubbard 3,223 (BRI); between Laidley and Granchester, moderately common on railway embankment, 5.9.1930, C. T. White 6,830 (BRI); Forrest Hill, on railway station, 297 ft., 28.11.1930, C. E. Hubbard (BRI); Gatton College, in dark brown silty clay on top of creek bank, fls. pale yellow, 26.2.1947, S. L. Everist 2,731



(BRI); Goomburra to East Greenmount, 15.9.1930, M. Ramsay (BRI); Silverwood, 9.1922, C. T. White 1750 (BRI); Noondoo Station, east of Dirranbandi, weed in sandy land, 15.12.1934, S. L. Everist 794 (BRI); Killawarra, Moonie River, common in red sandy soil, 4.1939, S. L. Everist 1799 (BRI); Kindon Station, about 54 miles N.N.E. of Goondiwindi, 5.12.1938, L. S. Smith 519A (BRI); Texas, 9.1910, J. L. Boorman (NSW 14,746).

*New South Wales*: Angledool, red slightly sandy soil, 1.7.1913, C. T. Musson (NSW 14,764); Yetman, 2.1949, E. G. Jacobs (NSW 14,712); Tenterfield, C. Stuart (MEL); Clarence River, Beckler (MEL); Emmaville Hill, 1.1911, J. L. Boorman (NSW 14,787); Wallangrah, w. of Inverell, 10.1929, N. J. Rodway (FAR); Mt. Russell, 1.2.1915, E. Breakwell (NSW 14,786); Gravesend, 5.1914, W. M. Carne (NSW 14,785); Ashley, 1.1925, E. H. Zeck (NSW 14,748); Baldersleigh, 25 miles west of Guyra, 6.11.1947, E. N. McKie (NSW 14,775); Baker's Creek, on Grafton road, 16 miles from Armidale, open Eucalypt forest, granite soil, 18.3.1951, G. L. Davis (NE); between Armidale and Uralla, roadside, 14.2.1940, G. L. Davis (FAR); Saumarez, 3500 ft., grassland, 14.2.1940, G. L. Davis (NE); George's Creek, Macleay River, 860 ft., grassland, 16.1.1941, C. Davis (NE); Barraba, 10.1912, H. M. Rupp (NSW 14,765); Narrabri, 1.1883, E. Betche (NSW 14,800); Boggabri, 11.1909, R. H. Cambage (NSW 14,799); Namoi, 1890, Musson (MEL); Gunnedah, 3.1914, W. L. Waterhouse (NSW 14,784); Tamworth, 20.10.1909, J. B. Cleland (AD); Walcha, 1884, A. R. Crawford (MEL); Baradine, 7.1947, K. Walton (NSW 14,782); Coonabarabran, 9.1916, J. L. Boorman (NSW 14,770); Binnaway, 5.1933, J. Rodway (FAR); Curlewis, 8.1913, E. Breakwell (NSW 14,760); Merriwa, 14.3.1924, E. Cheel (NSW 14,803); Wingen, 10.1909, R. H. Cambage (NSW 14,761); Scone, 8.1913, E. Breakwell (NSW 14,767); Belltrees, 2.1920, H. L. White (NSW 14,762); Bruschy Mts., 9.1897, J. H. Maiden (NSW 14,752); Clover Creek, Bourke, 1890, J. Mackay (MEL); Bourke to Cobar, 27.8.1926, C. S. Sutton (MEL); Cobar, 22.9.1924, A. Morris (NSW 14,792); Girilambone, 1.1917, J. L. Boorman (NSW 14,790); Nyngan, 5.1913, J. H. Maiden (NSW 14,776); Nevertire, 12.1923, A. Morris (NSW 14,789); Dubbo, 12.1907, J. L. Boorman (NSW 14,774); Gulgong, 4.1901, J. H. Maiden and J. L. Boorman (NSW 14,795); Wellington, 10.1883, E. Betche (NSW 14,791); Mudgee, 1870 (MEL); Euchareena, 6.1900, J. L. Boorman and C. Walter (MEL); 50 miles from Rylstone, near the Goulburn River, 10.1893, R. T. Baker (NSW 14,750); Capertee, 1.1.1900, J. L. Boorman (NSW 14,768); Manildra, 11.1907, J. L. Boorman (NSW 14,793); Bathurst, 1.1911, J. B. Cleland (AD); Newcastle, 1919, R. D. Rhone (MEL); Horse-shoe Bend, Grose Vale, 3.1910, W. M. Carne (NSW 14,758); Blackheath, 4.1909, J. H. Maiden (NSW 14,778); Hawkesbury Agricultural College, Richmond, 10.4.1910, W. Greenwood (NSW 14,766); Nepean River, 14.1.1888 (NSW 14,805); Penrith, 11.1912, E. Breakwell (NSW 14,757); Parramatta, 1871, W. Woolls (MEL); Cowan, 26.1.1918, W. F. Blakely (NSW 14,804); Asquith, on railway line, 6.1918, W. F. Blakely (NSW 14,797); Rookwood, 7.5.1881, J. J. Fletcher (NSW 14,802); Hurstville, 5.1901, J. H. Camfield (NSW 14,794); Como, 17.9.1881, J. J. Fletcher (NSW 14,806); Camden Park, 15.11.1949, L. A. S. Johnson (NSW 14,773); between Camden and Picton, 25.5.1930, F. A. Rodway (FAR); Shoalhaven River, at Nowra, roadside, 31.1.1943, F. A. Rodway (FAR); Cowra, E. Breakwell (NSW 14,753); Lachlan River, 9.1878, F. Mueller (MEL); Temora, 11.1915, J. W. Dwyer (NSW 14,781); Murrumbidgee River, 9.1878, F. Mueller (MEL); Wagga, 10.1881, J. J. Fletcher (NSW 14,801); junction of the Darling and Murray Rivers, 7.1889, Holding (MEL); on stony ridges near the Snowy River (MEL); Snowy River, 10.1851, F. Mueller (P); near the Snowy River, south of Jimenbuen, white Box-pine association, 23.11.1948, A. B. Costin (NSW 14,771); Kameruka, near Bega, dry roadside, 30.3.1937, F. A. Rodway (FAR); Mt. Imlay, near Eden, 12.1916, J. L. Boorman (NSW 14,763).

*Victoria*: Lower Hume's River and Mitta Mitta, 1.1874 (MEL); Neumerella, 28.5.1902, Grove (MEL); Orbost, 5.1902, J. Rowe (MEL); Tabbarabbera, 11.1930, Birch (MEL); dryish stony walls of Deacock Creek, Jungle Gully, near Glendadale, 26.1.1946, J. H. Willis (MEL); Deddick Creek, growing with *Cymbopogon refractus* on dry

granitic slopes, 17.1.1948, J. H. Willis (MEL); Gippsland, 1882, Howitt (MEL); Bacchus Marsh, 3.11.1910, J. R. Tovey (MEL).

*South Australia:* Flinders Range, 10.1851, F. Mueller (MEL); Torrens River, 3.1847, F. Mueller (MEL); Cudnaka, F. Mueller (MEL); around the city of Adelaide, 28.12.1847, F. Mueller (MEL); Murray Pine Scrubs, 10.1886, C. French (MEL).

*Western Australia:* Between Esperance Bay and Fraser's Range, 1876, Dempster (MEL); south-west Australia (MEL).

Among Steetz's specimens in the Melbourne Herbarium is an envelope containing infructescences of this species, and labelled "e specimine Bauerianae herb. aulicae Vindobonn". These fragments were presumably removed by Steetz from the type specimen and have been used in the present work as a basis of comparison for fruit characters. Another folder is labelled "Iter Australiense, 1802-5, R. Brown", and contains three specimens, one of which bears mature fruits identical with those from Bauer's specimen. Since Bauer accompanied Brown on this expedition these specimens may be part of the type series.

*C. polyseta* is represented in the Melbourne Herbarium by the type specimen ("Cudnaka, F. Mueller") which, although it agrees vegetatively with this species, has fruits which differ slightly in that the 2-lipped appearance is less conspicuous, due to the secondary awns being little shorter than the two major ones. Bentham (1866) regarded this species as "a very slight variety of *C. lappulacea*, with rather larger flower heads", and since the fruits have not been matched with those of any other specimens this synonymy is followed.

*C. suffruticosa* was described by Domin from a specimen collected by himself in 1910 ("savannah woodland near Jericho, Q.") and the type material has not been traced. According to Domin (1929) this species is allied to *C. lappulacea*, but differs in the involucre, the fact that the capitula are twice the size, and that the fruits bear two elongate awns and many short ones. The original description does not state in what way the involucre is distinctive, and the size of the capitulum is of little significance when a number of specimens are compared, while the awn characters mentioned by Domin as points of difference from *C. lappulacea* are actually ones of resemblance. The question does arise as to whether the material with which Domin compared his specimen was actually *C. lappulacea*. According to White (1946) these two species are to be distinguished by *C. lappulacea* having a "pappus of 4-8 unequal free awns", whereas *C. suffruticosa* has a "pappus of two awns with a number of very reduced ones or setae united at the base". This distinction cannot be upheld since all the specimens listed above conformed to the second species and none were seen in which all the awns were free.

*C. microphylla* ("Ferd. Bauer") was described by Bentham at the same time as *C. lappulacea* from which he distinguished it as having "capitula a little smaller, more hispid, the awns shorter and less strong". These differences, however, are not taxonomically significant, and consequently *C. microphylla* is relegated to the synonymy implied by Bentham in not referring to it in "Flora Australiensis".

The general facies of *C. lappulacea* is very constant despite some slight variation in the shape of the lower cauline leaves, which, however, are usually obscured by the much-branched habit of the plant. Variation in the fruits is confined to the number of supernumerary spines and does not affect the characteristic 2-lipped appearance when seen from above. In certain specimens a second tier of very short awns is present (Text-fig. 73).

11. *CALOTIS GLABRESCENS* C. T. White, *Proc. Roy. Soc. Q.*, 57 (1946), 30. (Text-figs. 80-84.)

*Holotype*, Darling Downs: Bybera, between Inglewood and Millmerran, moderately common in open forestland, herb, fls. white, turning to purple when drying, 20.9.1944, C. T. White (BRI).

Slender erect perennials up to 15 cm. high, branching from the base and subsequently, with a few scattered septate hairs on the leaves and stems. *Leaves* cauline,



Text-figures 70-101.

70-79, *C. lappulacea*.—70, Habit  $\times 0.3$ ; 71, Fruit  $\times 9$ ; 72-73, Variation in fruits, apical view  $\times 9$ ; 74-78, Variation in lower cauline leaves  $\times 0.3$ ; 79, Distribution; 80-84, *C. glabrescens*.—80, Habit  $\times 0.3$ ; 81, Fruit  $\times 6.3$ ; 82-83, Variation in fruits, apical view  $\times 6.3$ ; 84, Distribution; 85-94, *C. scabiosifolia* var. *scabiosifolia*.—85, Habit  $\times 0.3$ ; 86, Fruit  $\times 6.3$ ; 87-93, Variation in radical leaves  $\times 0.3$ ; 94, Distribution ( $\times$ ); 95-101, *C. scabiosifolia* var. *integrifolia*.—95, Habit  $\times 0.3$ ; 96, Fruit  $\times 6.3$ ; 97-100, Variation in radical leaves  $\times 0.3$ ; 101, Distribution ( $\bullet$ ).

up to 5.5 cm. long, 3 mm. broad, narrow-oblongate to linear, acute, entire or with a single lateral tooth. Upper leaves sessile, the lower basally attenuate. *Inflorescences* up to 16, 1.8 cm. diameter, on terminal or axillary naked peduncles. *Involucral bracts* about 16, 2.5-3.5 mm. long, 0.7-1 mm. broad, linear, obtuse, entire, septate-hairy. *Ray florets* about 30, the rays 6.5 mm. long, 1 mm. broad, white. *Fruits* dark brown, the body cuneate, 1.5-1.7 mm. long, 1.5-2 mm. broad, glabrous, with 2-3 rigid major awns 2-3.2 mm. long, distally barbed and proximally hairy, horizontal in position but not constant in arrangement and interspersed with very short awns which bear numerous long hairs and are not barbed.

*Specimens examined*: Type series only.

White (1946) expressed the opinion that this species was most closely allied to *C. suffruticosa*, but as has been pointed out above, all specimens of that species in the Brisbane herbarium fall well within the specific limits of *C. lappulacea*, and his statement must be modified accordingly. Although the type series is composed of seven specimens, only one of them bears fruits, and the wisdom of establishing a new species on such scanty material might well be questioned when such a close similarity exists to another species. The chief distinguishing feature from *C. lappulacea* is the awn arrangement which itself was found to vary within the head, some fruits being indistinguishable from those of *C. lappulacea*. Whether this is a valid species or not cannot be decided until further material is collected.

12. *CALOTIS SCABIOSIFOLIA* Sond. et F. Muell., *Linnaea*, 25 (1852), 471.

Erect septate-hairy stoloniferous perennials up to 44 cm. high, with a basal cluster of leaves. *Radical leaves* up to 18.5 cm. long, 7-40 mm. broad, petiolate, linear and entire or lanceolate to elliptical and toothed, pinnatifid or pinnatipartite, the segments sometimes again toothed. Upper cauline leaves sessile, entire or acutely toothed. *Inflorescences* up to 31, 1.7-3 cm. diameter. *Involucral bracts* 18-30, the outer 3.5-9 mm. long, 1.3-4 mm. broad, elliptical, subacute to acuminate. *Ray florets* 15-65, the rays 7.5-12 mm. long, 1.2-3 mm. broad, white or mauve. *Receptacle* 3.5-4 mm. broad, 1.5 mm. high, hemispherical, pitted, with long narrow scale-like septa between the bases of the florets. *Fruits* pale to dark reddish-brown, 2.7-4 mm. long, 1.6-3.5 mm. broad, cuneate, flattened. Major awns 5-6, stout, rigid, microscopically barbed distally, proximally hairy, 0.8-4 mm. long. Secondary awns, when present, 0.5-1 mm. long, hairy, without distal barbs, the smallest sometimes obscured by the long woolly hairs.

*Key to the Varieties.*

Radical leaves distally expanded, serrate or variously dissected.

Body of fruits glabrous on central area ..... var. *α scabiosifolia*.

Radical leaves entire or occasionally with 2-5 linear distal lobes.

Body of fruits with many long appressed hairs on central area ..... var. *β integrifolia*.

*C. SCABIOSIFOLIA* Sond. et F. Muell., var. *α SCABIOSIFOLIA* comb. et stat. nov. *Linnaea*, 25 (1852), 471. (Text-figs. 85-94.)

*C. Muelleri* Sond., *Linnaea*, 25 (1852), 470.

*Type data*: "In meadows near Wulpena, Octob. Murray."

*Lectotype*, "Wulpena, Nov. Holl. Austr., Ferd. Mueller" (MEL).

*Radical leaves* lanceolate to elliptical in gross outline, serrate, pinnatifid or pinnatipartite, the segments entire or serrate. The leaf blade tapers, often abruptly, into a petiole of approximately the same length as the blade. Fruits with 5-6 robust apically barbed and proximally hairy awns; body glabrous.

*Habitat*: No data.

*Range*: Southern Queensland, western New South Wales and Victoria, Spencer's Gulf district of South Australia.

*Specimens examined*:

*Queensland*: Charleville, 1869, E. Giles (MEL); Goomburra, 15.9.1930, M. Ramsay (BRI); Darling Downs district, about three miles S.E. of Blaxland, 13.10.1940, L. S. Smith, S. L. Everist 803 (BRI; MEL).



*New South Wales*: Warrego River, 9.1885, E. Bêche (NSW 14,916); near Queensland border north of Bourke, 9.1884, L. Henry (MEL); Bourke district, O. C. McDougall (NSW 14,926); Warialda, 10.1914, J. L. Boorman (NSW 14,927); Curriwillingham Walgett, T. C. Dalton (MEL); Namoi River, 3.1887, A. Carson (MEL); Liverpool Plains, Leichhardt (MEL); Coolabah, 10.1900, R. W. Peacock (NSW 14,917); Gulargambone, 9.1886, Cardell (NSW 14,951); Nyngan and Nevertire, 23.9.1924, A. Morris (NSW 14,925); near Cobar, 9.1910, L. Abrahams (NSW 14,922); near Wilcannia, 27.1.1924, W. MacGillivray (NSW 14,920); Mossgiel, 1885, J. Bruckner (MEL); Condobolin flats, 8.1897, J. H. Maiden (NSW 14,918); Wentworth, 10.1887, J. Minchin (MEL); Darling River, junction with Murray, Dallachy and Goodwin (MEL); Balranald, 1878, Lucas (MEL); Murrumbidgee River, 9.1878, F. Mueller (MEL); Zara, Wanganella, near Hay, 10.1917, E. Officer (MEL; NSW 14,919); Jerilderie, 10.1920, J. W. Dwyer (NSW 14,953); Berrigan, 29.10.1920, J. L. Sones (MEL).

*Victoria*: Swan Hill, 1890, J. G. Luckmann (MEL); Kerang, 10.1887, J. Minchin (MEL); Prairie, 22.8.1928, C. S. Sutton (MEL); Campaspe River, 10.1875 (MEL); north-west of Lake Albacutya, 9.1887, C. French (MEL); north of Lake Hindmarsh, 10.1892, St. Eloy D'Alton (MEL); Birchip, 11.9.1927, C. S. Sutton (MEL); Jarklin, 9.10.1925, A. Morris (MEL); near Rifle Range, Wycheproof, 9.1917, W. W. Watts (MEL); Jeparit, 16.9.1916, W. R. Baker (MEL); Nhili, 10.1922, J. B. Williamson (MEL); Dimboola, 16.9.1898, F. M. Reader (MEL); Donald, Curdie (MEL); Minyip, 1890, J. P. Eckert (MEL); Horsham, 11.1904, M. Thurman (MEL); Wimmera, Dallachy (MEL); Avoca, 1.12.1853, F. Mueller (MEL); Werribee, Fullagher (MEL); Little River, 1.11.1904, P. R. H. St. John (MEL); between Geelong and Station Peak, 1.1853, F. Mueller (MEL); dry places about Station Peak (MEL); Sydenham, 26.9.1912, P. R. H. St. John (MEL).

*South Australia*: Wilpena, F. Mueller (MEL); near upper end of Spencer's Gulf, 1887, L. Wehl (MEL); Yorke's Penin., 1888, E. Beythieu (MEL); Cudnaka, 10.1851 (MEL).

Five specimens collected by Mueller at the type locality are in the Melbourne Herbarium, and although three of these are in rather a fragmentary state, the remainder are sufficiently intact to be nominated lectotype and lectoparatype respectively. Both the original description and the label accompanying these specimens cite the locality as "Wulpena", but as no place of that name has been traced, it is thought to refer to "Wilpena".

Sonder described *C. Muelleri* ("Cudnaka") from specimens which differed from *C. scabiosifolia* in the possession of lanceolate, toothed leaves and small tubercles on the flattened faces of the fruits. In the absence of further similar specimens the present writer regards this species as a local variant of *C. scabiosifolia*, thereby following Bentham (1866).

Vegetative variation within var. *scabiosifolia* is very marked in the radical leaves, in which the degree of dissection of the blade is sometimes extreme. Specimens from the Warrego River and Gungerwarildli bear serrate leaves (Text-fig. 92) while those from Coolabah, Nevertire, Nyngan and Hay (Text-figs. 86-88) are coarsely and regularly toothed. Deepening of the indentations between the teeth leads to the pinnatipartite and pinnatisect conditions seen in specimens from Lake Cargellico and Condobolin in which the leaf lobes are commonly themselves serrate (Text-figs. 89-92).

The body of the fruit shows little variation except in size, and long woolly hairs are always present within the circlet of awns. Fruits of the type series bear 5-6 major awns and 2-3 secondary ones, but in the specimens examined by the writer an interesting series was found which may have a bearing on awn phylogeny. At one end of the series are the specimens from the Campaspe River, Jarklin and Darling River, whose fruits bear 6-11 very short awns which are little more than teeth and the barbs are few in number or absent; at the other are those with fruits whose awns equal or exceed the body in length and are provided with numerous backwardly directed barbs. Between these two extremes all intermediate conditions have been found with no correlation in vegetative characters.

*C. SCABIOSIFOLIA* VAR.  $\beta$  *INTEGRIFOLIA* F. Muell. ex Benth., *Fl. Aust.*, 3 (1866), 503. (Text-figs. 95-101.)

*C. scabiosifolia* var. *lasiocarpa* F. Muell. ex Benth., *Fl. Aust.*, 3 (1866), 503.

*Type data*: "Blue Mts., A. Cunningham and others; grassy mountains on the Macallister River and Black Forest, F. Mueller."

*Lectotype*, "Grassy mountains on the M'Allister River, Gippsland, F. Mueller" (MEL).

Sturdy perennials up to 35 cm. high, with 1-3 main stems. The middle and upper *cauline leaves* are sessile and acutely toothed or lobed, while the radical and lowest *cauline leaves* form a basal cluster, and are up to 15 cm. long, 8 mm. broad, linear to oblanceolate, acute, entire or occasionally with a few narrow acute lobes. *Fruits* bear 4-6 robust major awns which are distally barbed, hairy proximally, and equal to, or exceeding, the body in length, as well as a number of short unbarbed secondaries. The central area of each fruit face is provided with many appressed hairs, and long woolly hairs cover the apex of the fruit and may obscure the bases of the awns.

*Habitat*: Grassland and open forest.

*Range*: Central highlands and middle-western districts of New South Wales, to highlands of Victoria.

*Specimens examined*:

*New South Wales*: Orange, 11.1907, W. F. Blakely (NSW 14,952); Wallerawang, 11.1899, J. H. Maiden (NSW 14,937); Wingello, 12.1913, J. L. Boorman (NSW 14,938); Cavan, near Yass, I. L. Calvert (MEL); Gudgenby, Queanbeyan, 14.1.1912, R. H. Cabbage (NSW 14,941); near Wagga, 11.1897, J. H. Maiden (NSW 14,940); Yarrangobilly Caves, 2.1897, E. Betche (NSW 14,939); Yarrangobilly Mt., near summit, 12.1.1940, J. Vickery (NSW 14,935); Kiandra, 12.1901, W. Forsyth (NSW 14,946); Monaro, on the mountains, in grass, F. Mueller (MEL); Cooma, widespread in *Stipa* savannah, *E. pauciflora* woodland, *E. melliodora* woodland, dry sclerophyll forest and *E. pauciflora*-*E. Dalrympleana* forest, 17.11.1948, A. B. Costin (NSW 14,943); Nimity-belle to Tantawango Mts., 12.1896 (AD); Tumbarumba, 11.1926, J. W. Dwyer (NSW 14,942); Mt. Kosciusko, gully, among *E. gigantea*, 4.1947, A. B. Costin (MEL).

*Victoria*: Mitta Mitta, 1.1920, S. F. Clinton (MEL); grassy mountains on the Snowy River, 1.1853, F. Mueller (MEL); Strathbogie, 11.1901, A. W. Vroland (NSW 14,930); Upper Loddon, 1874, F. Mueller (MEL); Ranges on the Macallister, 500-3000 ft., F. Mueller (MEL); grassy mountains on the Macallister River (MEL); Upper Yarra, 9.1892, C. Walter (NSW 14,933); Dandenong Ranges, 11.1901, C. Walter (NSW 14,934); Mt. Dandenong, near Devil's Elbow, 1.10.1902, P. R. H. St. John (MEL); Ringwood, 11.1922, A. J. Tadgell (MEL); Dromana, 11.1902, G. Weindorfer (MEL).

Mueller (1866) described var. *lasiocarpa* ("Snowy and Macallister Rivers and Maneroo, F. Mueller") as differing from the species proper by "leaves more rigid, less toothed. Flower heads and achenes larger". Comparison of the type specimens of this and var. *integrifolia*, however, showed that they were not sufficiently distinct to merit separate status. In each case a lectotype was selected and the epithet "*integrifolia*" retained.

Vegetative variation is limited to the occasional presence of a few narrow acute lobes on some of the radial leaves and the degree of dissection of the *cauline leaves*. Some dwarf specimens from Queanbeyan bore radical leaves 2 cm. long and 2.5 mm. broad, but usually these plants are robust and the radical leaves are approximately half the length of the mature scapes.

### 13. *CALOTIS CUNEATA* (F. Muell. ex Benth.), n. comb.

Stoloniferous perennials up to 30 cm. high. *Radical leaves* up to 10.5 cm. long, 1.8 cm. broad oblanceolate, coarsely toothed to the base or only distally and forming a basal cluster. *Cauline leaves* cuneate to ovate-cuneate, toothed. *Inflorescences* 16, up to 2.5 cm. diameter. *Involucral bracts* 18-30, 3.5-4.5 mm. long, 1.2-4 mm. broad, elliptical, acute, entire. *Ray florets* about 40, the rays 9 mm. long, 1.5 mm. broad, usually white but occasionally pale lavender. *Receptacle* about 1.5 mm. high, 1.5 mm.

broad, hemispherical, with long forked filiform septa between the bases of the florets. *Fruits* 1.6-3.8 mm. long, 1.5-3.7 mm. broad, cuneate, with 4-6 proximally woolly major awns; secondary awns numerous and hairy. An inner ring of about 12 fine awns is present which have an almost plumose appearance due to long straight hairs at right angles to the axis.

*Key to the Varieties.*

Radical leaves cuneate, coarsely toothed distally, sparsely septate-hairy. Body of fruits glabrous with no demarcated central area ..... var. *α cuneata*.

Radical leaves usually 3-toothed distally, woolly hairy. Body of fruits with many long appressed hairs on central area ..... var. *β pubescens*.

*C. CUNEATA* (F. Muell. ex Benth.), n. comb. var. *α CUNEATA*, comb. et stat. nov. (Text-figs. 102-104.)

*C. scabiosifolia* Sond. et F. Muell., var. *cuneata* F. Muell. ex Benth., *Fl. Aust.*, 3 (1866), 503.

*Type data*: "Rockhampton and Keppel Bay, Thozet, Burdekin River and desert on the Suttor, F. Mueller."

*Lectotype*. Rockhampton, Thozet (MEL).

Weakly erect and often tufted plants, up to 44 cm. high, with several, usually branched, stems with ovate-cuneate to elliptical, sessile, entire or shortly toothed leaves. *Radical leaves* up to 14 cm. long, 1.8 cm. broad, cuneate, obtuse, toothed distally or along the whole margin, and forming a basal cluster. *Ray florets* white, occasionally pale lavender. *Fruits* glabrous with no specially demarcated central area on the body. Major awns 4-6, the distal half barbed and woolly proximally. Secondary and super-numerary awns about 12, with no or few barbs and many woolly hairs. Inner awns fine, not rigid, about 11, with a plumose appearance due to the presence of long straight hairs at right angles to the awn axis.

*Habitat*: On various soils in grassland or open country.

*Range*: Widely spread in Queensland.

*Specimens examined*:

*Queensland*: Rockhampton, Thozet (MEL); Rockhampton, grassy bank of Fitzroy River, ca. 18 ft. alt., 27.2.1931, C. E. Hubbard 8,029 (BRI); Keppel's Bay, Thozet (MEL); Port Curtis district, Serpentine Water Reserve, 14.3.1948, L. J. Webb (BRI); Wood End, Rockhampton district, 3.1920, W. D. Francis (BRI); between Capella and Clermont, 5.1929, Sutton (MEL); Emerald, 8.1912, J. L. Boorman (NSW 14,929); between Emerald and Longreach, 10.1913, E. Jarvis (BRI); Blackall, "in damper more or less shady places on bank of Barcoo River, ca. 900 ft., leaves tufted, dark green above, paler beneath, ray white, 14.7.1934, S. T. Blake 6,753 (BRI); Blackall-Northampton Downs, tufted plant very close to the ground, ray florets white or pale lavender, on heavy chocolate soil near edge of clay pan, 26.8.1935, S. L. Everist 1,283 (BRI); Augathella, common on black soil plains, flowers white, 15.12.1941, C. T. White 11,648 (BRI); Wandoan, in open *Eucalyptus populifolia* forest with *Aristida*, heavy soil, ca. 900 ft., 15.11.1930, C. E. Hubbard 4,968 (BRI); Mitchell, in grassland on dark greenish-brown silty clay, ca. 1100 ft., leaves prostrate, ray white, 3.5.1934, S. T. Blake 5,717 (BRI); Roma, in open grassy places on clayey soils, ca. 1000 ft., leaves tufted, ray white, 29.3.1936, S. T. Blake 10,887 (BRI); Rosedale, common on gravelly loam, Ironbark forests, 25.2.1931, L. G. Dovey (BRI); Gayndah, 9.1913, F. H. Kenny (BRI); Chinchilla, on brown sandy soil in grassland, 992 ft., 7.1.1931, C. E. Hubbard and C. W. Winders 6,438 (BRI); Forest Hill, 11.1921, F. Coleman (BRI); Laidley, 3.1920, C. T. White (BRI);

The type series is represented in Australia by specimens collected by Thozet at Rockhampton and Keppel's Bay, one from the former locality being selected as lectotype.

Collector's notes indicate that the radical leaves form a conspicuous basal cluster and are commonly closely appressed to the ground; this is not always apparent from herbarium specimens.



Text-figures 102-122.

102-104, *C. cuneata* var. *cuneata*.—102, Habit  $\times 0.3$ ; 103, Fruit  $\times 9$ ; 104, Distribution ( $\times$ ); 105-107, *C. cuneata* var. *pubescens*.—105, Habit  $\times 0.3$ ; 106, Fruit  $\times 6.3$ ; 107, Distribution ( $\bullet$ ); 108-111, *C. latiuscula*.—108, Habit  $\times 0.3$ ; 109, Fruit  $\times 6.3$ ; 110, Fruit, apical view  $\times 6.3$ ; 111, Distribution; 112-119, *C. scapigera*.—112, Habit  $\times 0.3$ ; 113, Fruit  $\times 6.3$ ; 114-118, Variation in radical leaves  $\times 0.3$ ; 119, Distribution; 120-122, *C. incrimis*.—120, Habit  $\times 0.3$ ; 121, Fruit  $\times 6.3$ ; 122, Distribution.



Mueller, in preceding the varietal name by a question mark in the original description, appears to have been in doubt as to the status of the specimens he examined. As in the other varieties of *C. scabiosifolia* described at the same time, he confined himself to vegetative characters such as leaf shape and margin, which are unsatisfactory criteria in such a variable species. However, the presence of an inner row of awns in the fruits separates this population as a separate entity of specific status.

*C. CUNEATA* (F. Muell. ex Benth.), n. comb. var.  $\beta$  *PUBESCENS* (F. Muell. ex Benth.), n. comb. (Text-figs. 105-107.)

*C. scabiosifolia* Sond. et F. Muell. var. *pubescens* F. Muell. ex Benth., *Fl. Aust.*, 3 (1866), 503.

*Type data*: "Mountains on the Mitta Mitta River, F. Mueller."

*Lectotype*. "Grassy mountains on the Mitta Mitta. F. Mueller" (MEL).

Densely septate-hairy perennials 9 cm. high, with cuneate, apically toothed *cauline leaves*. *Fruits* 3-8 mm. long, 3-8 mm. broad, hairy on central area of each face and with 4-5 major awns between which are numerous supernumeraries with long hairs. Major awns not barbed and are proximally hairy. A second inner ring of plumose awns is present.

This variety is known only from the type specimen which is rather fragmentary, and is apparently extremely rare.

The body of the fruit most resembles that of var. *integrifolia* and the second ring of awns is a character shared with var. *cuneata*, but the unbarbed major awns is a unique feature.

14. *CALOTIS LATIUSCULA* F. Muell. et Tate, *Trans. Proc. Roy. Soc. S. Aust.*, 13 (1890), 107. (Text-figs. 108-111.)

*Type data*: "Central Australia. This plant has also been gathered near the Finke River by the Rev. H. Kempe."

*Lectotype*, Finke River, 1882, H. Kempe (MEL).

Erect branching septate-hairy perennials (?), up to 40 cm. high with a long tap root. *Radical leaves* up to 7 cm. long, 1.5 cm. broad, oblanceolate, the serrate blade tapering into a petiole of equal length, but only present on young plants. *Cauline leaves* up to 6 cm. long, 1.1 cm. broad, oblanceolate to cuneate, dentate or entire, acute, sessile. *Inflorescences* about 50, 1.5 cm. diameter, in a terminal cymose panicle. *Involucral bracts* 16-18, 2.5-3.7 mm. long, 0.7-1.1 mm. broad, linear, acuminate, entire, septate-hairy. *Ray florets* 10-21, the rays 4.5 mm. long, 1.6 mm. broad, yellow. *Receptacle* steeply conical, 1.5 mm. broad, 1-1.5 mm. high, the septa between the florets dissected into long scale-like processes. *Fruits* light brown, flattened, about 2 mm. long, 1 mm. broad, glabrous, the body not sharply defined. Awns 6-10, up to 3 mm. long, unequal, distally barbed, rigid, united basally, and passing off from the fruit at right angles; apex of fruit projects above the bases of the awns as a hairy central cone.

*Habitat*: No data.

*Range*: Central Australia and extending into the northern portion of South Australia and north-western New South Wales, with a single record from Western Australia.

*Specimens examined*:

*New South Wales*: Evelyn Creek, north of Barrier Range, 1887, A. King (MEL); near Mt. Wanaaring, 1.1941, A. B. Chislett (NSW 14,961).

*Northern Territory*: Macdonnell Range East, 5.1875, E. Giles (MEL); south side of Gill's Range, 1884, R. Tate (AD); Tempe Downs, 1888, R. F. Thornton (MEL); Mt. Sonder, W. Tietkins (MEL); Arltunga goldfield, 7.1922, C. G. F. Allen (NSW 14,865); Alice Springs, 7.1922, C. G. F. Allen (NSW 14,868); Finke River, 1882, H. Kempe (MEL); near the Finke River, Gosse's Range, Swartz and Schultz (MEL); Charlotte Waters, 1887, P. M. Byrne (MEL); Ernabella, in open country, 13.12.1943, L. B. Young (MEL); between the Alberga and Mt. Olga, 1873-4, Giles (MEL).

*South Australia*: North of Lake Eyre, 6.1887, H. Newland (MEL); Upper Arkaringa Valley, 22.5.1891, R. Helms (AD; NSW 14,864).

*Western Australia*: Murrin, 4.1907, F. A. Rodway (MEL).

A number of specimens are extant which were collected in the Finke River area by H. Kempe and a lectotype was selected from these.

The species shows little variation of any type and is easily recognized by its rather compact cymose panicles and large sessile cauline leaves. The fruits are very distinctive in their possession of robust horizontal awns and the extreme development of the central cone which exceeds the length of the body and the shorter awns.

15. *CALOTIS SCAPIGERA* Hook. in Mitch., *Journ. Trop. Austral.* (1848), 75. (Text-figs. 112-119.)

*C. scapigera* Hook. in Mitch. var. *dentata* Sond., *Linnæa*, 25 (1852), 472; *C. scabiosifolia* Sond. et F. Muell. var. *elongata* F. Muell. ex Benth., *Fl. Aust.*, 3 (1866), 503.

*Type data*: None.

*Haptotype*, Subtropical New Holland, 1846, T. L. Mitchell (NSW 14,641).

Stoloniferous perennials, 7-38 cm. high, with a basal cluster of radical leaves up to 24.5 cm. long, 8 mm. broad. *Leaves* linear to linear-lanceolate, acute, entire or sparsely toothed, occasionally with a few linear lobes, almost glabrous. *Stems* 1-5, usually unbranched and scape-like, exceeding the leaves, and bearing a few bract-like or small leaves. *Inflorescences* up to 10, 1.5 cm. diameter. *Involucral bracts* about 15, 3.5 mm. long, 1.5 mm. broad, oblanceolate, obtuse and entire. *Ray florets* 22-40, the rays 2.5-5 mm. long, 0.5-1 mm. broad, white or lavender. *Receptacle* hemispherical, 1.3 mm. broad, 0.5-1 mm. high. *Fruits* brown, the body cuneate, flattened, glabrous, 1.7-2.5 mm. long, 1.2-2.4 mm. broad. *Awns*, 4-6, rigid, diverging, straight or subulate, more or less equal, 1-4 mm. long, microscopically barbed distally and woolly proximally.

*Habitat*: On rather heavy soils.

*Range*: Eastern States and south-eastern portion of South Australia.

*Specimens examined*:

*Queensland*: Canal Creek, 1882, Hartmann (MEL); Dingwall, on grey clay flat with much gypsum, ray florets yellow, white or pale mauve, 19.7.1948, S. L. Everist 3,489 (BRI); Dalby, 30.9.1950, H. J. Anderson (BRI); Toowoomba, H. G. Longman (BRI); Noondoo, near Dirranbandi, at edge of tank on grey heavy soil, ca. 550 ft., ray white, 1.3.1936, S. T. Blake 10,627 (BRI).

*New South Wales*: Glen Innes, 9.1910, F.H.R. (AD); Armidale, rays white, gravelly loam soil, 20.1.1941, G. L. Davis (NE); West Maitland 11.1908, S. Brewster (NSW 14,640); Concord, Woolls (NSW 14,960); Burwood, 1890, Woolls (MEL); Narrabri, 10.1933 (NSW 14,630); Euralah, via Walgett, 9.1912, L. K. Clank (NSW 14,629); Macquarie River (NSW 14,632); Bourke, 8.1896, J. H. Maiden (AD); Bourke, flowers white, 5.1918, J. L. Boorman (NSW 14,636); Warrego River, 9.1885, E. Betche (NSW 14,637); Sub-tropical New Holland, 1846, T. L. Mitchell (NSW 14,641); Wilcannia, 6.1893, Tepper (MEL); 20 miles from Menindie, clay, 14.10.1860, Victorian Expedition (MEL); Wentworth, Ford (MEL); Booberoi, Lachlan River, swampy land, 2.1941, N. C. Beadle (NSW 14,634); Murrumbidgee River, 2.1893, E. Betche (NSW 14,959; MEL); Narrandera, 4.1932, B. J. Shadbolt (NSW 14,635); Howlong, Community Park, white rays turning pink on drying, fairly common but inconspicuous among tall herbage, mixed with *Hemarthria*, *Mentha*, *Pulegium* and *Paspalum distichum*, 8.2.1950, E. J. McBarron (NSW 14,633).

*Victoria*: Shire of Dimboola, 1891, F. M. Reader (MEL); near Mt. Macedon, 1873, D.S. (MEL); Stordley Park, Melbourne, 3.9.1883, F. Reader (MEL); Port Phillip, F. Mueller (MEL); Geelong, 3.1906, H. B. Williamson (MEL).

*South Australia*: Renmark, rays white in two irregular rows, rare, 4.10.1915, J. M. Black (JMB); Swan Reach, 19.3.1927, J. B. Cleland (JBC); Murray Bridge, ray pink turning white, 16.10.1918, J. M. Black (JMB); between North Arm and Hindmarsh, rays pinkish lilac, 4.1849, Wirth (MEL); Port Adelaide, 22.6.1910, H.H.D.G. (JMB); Mannum river flats, J. B. Cleland (JMB).

The original description gives no locality data as such, though from the title of the book, it is to be supposed that the specimens were collected between Sydney and the Gulf of Carpentaria, probably in New South Wales. In the National Herbarium, Sydney, there is a folder of specimens accompanied by a printed label "Sub-tropical New Holland, 1846, Col. Sir T. L. Mitchell", which presumably form part of the type series. The material consists of one plant with flowering and fruiting heads (haptotype) and four others, without heads, connected by stolons. All conform to the original description except that instead of the scapes being naked, as stated by Mitchell, they bear small and inconspicuous bracts. The majority of specimens examined agree with the haptotype in the possession of scapes, but in some (Geelong, Port Philip, Melbourne and Dingwall) a lateral branch is present and in one from Glen Innes, each so-called scape is branched twice. Although entire leaf margins is the usual condition in this species, in the specimens from Dingwall most of the leaves are finely serrate. A further variation was seen, chiefly in Queensland specimens, in which among the usual entire leaves were a few bearing 3-6 linear acute lobes up to 7 mm. long, at right angles to the mid-vein of the leaf. This last condition was seen in Mueller's type specimen of *C. scabiosifolia* var. *elongata* (Port Phillip), in which the leaves are 22 cm. long, 2.5 mm. broad, but whose fruits are identical with those of *C. scapigera*. Sonder's type specimen of *C. scapigera* var. *dentata* (Australia. Herb. Aulic. Vindob. ec Mus. Paris n. 397) has not been examined by the present writer, but his description ("leaves equal to the scapes, basally narrowed, entire or dentate with 3-4 lanceolate teeth") suggests that this also is an example of the last-named variation.

16. *CALOTIS INERMIS* Maiden et Betché, PROC. LINN. Soc. N.S.W., 26 (1901), 84. (Text-figs. 120-122.)

*Type data*: "Urisino, 20 miles west of Wanaaring, on the Paroo River, Sept. 1900, E. Betché."

*Leiotype*, Urisino, Paroo River district, 9.1900, E. Betché (NSW 14,869).

Herbaceous branching annuals up to 16 cm. high, more or less septate hairy. *Cauline leaves* numerous, up to 2.5 cm. long, 1.5 cm. broad, cuneate, sessile, 5-7 toothed distally, tapering rather abruptly into a narrow basal portion which is slightly stem-clasping. *Radical leaves* lanceolate, serrate, up to 4.5 cm. long, 0.8 cm. broad, only present on young plants. *Inflorescences* up to 26, 2.5 cm. diameter. *Involucral bracts* about 20, 3.5-4 mm. long, 1.2-1.5 mm. broad, lanceolate, acuminate, entire, densely hairy. *Ray florets* 18-23, the rays up to 7 mm. long, 2.5 mm. broad, purple. *Receptacle* 1-2 mm. broad, 1-2 mm. high, hemispherical, slightly pitted. *Fruits* 2.5 mm. long, 1.2 mm. broad, elliptical, flattened, pale brown, microscopically hairy; awns 12-15, 10-15 mm. long, fine and flexible, without barbs but with numerous fine straight hairs given off at right angles.

*Habitat*: On red-brown clay or loam soils.

*Range*: Western Queensland to Paroo River district of New South Wales.

*Specimens examined*:

*Queensland*: Currawilla, near Moncarbey Creek, in hard bare pebbly red-brown loam, annual with numerous erect stems, ray florets bright purple, 13.6.1949, S. L. Everist 4,010 (BRI); Currawilla, Stallion paddock, in red-brown clay loam with *Cassia phyllodinea*, annual with rosette of leaves and several short flowering stems, 9.6.1949, S. L. Everist 3,914 (BRI); Dynevor Downs, on hard stony ridges, flowers deep mauve, 2.4.1941, C. T. White 11,827 (BRI; NSW 14,870); Goonamurra, near Eulo, small erect herb on hard red soil flats; ray florets purple, 20.9.1938, S. L. Everist 1,656 (BRI).

*New South Wales*: Wanaaring-Urisino, 10.1900, J. L. Boorman (NSW 14,871); Urisino, Paroo River district, 9.1900, E. Betché (NSW 14,869; MEL).

The fruits of *C. inermis* are unique in that the awns are long, soft and feathery and consequently do not possess the burr-like properties of most other species. It is possibly due to this that it occupies such a limited range compared with others whose rigid barbed awns become readily attached to passing animals.

*C. inermis* appears to be a rare plant and no variation was shown in the short series of specimens available. Its very limited distribution may perhaps be attributed to the absence of rigid awns as a means of mechanical distribution by animals.

17. *CALOTIS BREVISETA* Benth., *Enum. Pl. Hueg.* (1837), 60. (Text-figs. 123-125.)

*C. tropica* F. Muell. in *Trans. Phil. Inst. Vict.*, 3 (1859), 58; *C. pterosperma* R.Br. ex Benth., *Fl. Aust.*, 3 (1866), 505.

*Type data*: "Ferd. Bauer."

Erect perennials up to 35 cm. high, branching from the base and subsequently, glabrous or sparsely septate-hairy. *Leaves* cauline, linear to narrow-oblongate, up to 3.5 cm. long, 6 mm. broad, acute, entire or occasionally with 1-2 small lateral teeth. *Inflorescences* over 100 on an established plant, 5-7 mm. diameter. *Involucral bracts* 30-40, 2.5 mm. long, 0.5 mm. broad, narrow lanceolate, acuminate, entire, very sparsely septate hairy. *Ray florets* 26-34, the rays 2-3 mm. long, 0.5 mm. broad, white. *Receptacle* 0.8 mm. broad, 0.8-1 mm. high, conical, pointed, shallowly pitted. *Fruits* reddish to dark brown, 1.4-2 mm. long, 1.2-1.5 mm. broad, slightly flattened, the body cuneate with a few white or straw-coloured simple hairs, and a conspicuous hairy apex forming a central cone; wings rather thick and narrow with simple marginal hairs; awns 7-10, stout, barbed, the same length or slightly exceeding the central cone.

*Habitat*: "Dry beds of rivers" (Mueller, 1859) and barren country.

*Range*: North and North-western Australia from Arnhem Land to the Kimberleys.

*Specimens examined*:

*Northern Territory*: Port Darwin, ray white, 10.1888, M. Holtze (MEL); Spring Vale, Port Darwin, Giles (BRI); Telegraph Line, 200 miles south of Port Darwin, A. Giles (MEL); Edith Creek, 7-8.1911, W. B. Spencer (NSW 14,985); Albert River, Henne (MEL); Driffield Creek, 7-8.1911, W. B. Spencer (NSW 14,983); Maude's Creek, 7-8.1911, W. B. Spencer (NSW 14,901; 14,984); Katherine River, 12.1886, A. Giles (MEL); low barren country towards the Fitzmaurice River and McAdams Range, 10.1885, F. Mueller (MEL); Upper Victorian River, rays white, 12.1885, F. Mueller (MEL).

*Western Australia*: near Cambridge Gulf, 1887, W. J. O'Donnell (MEL); west of Cambridge Gulf, 1887, A. J. Keiller (MEL); King Sound, 1888, Froggatt (NSW 14,900; MEL); Fitzroy River, 8.1906, W. V. Fitzgerald (NSW 14,902); Beagle Bay, 1879, A. Forrest (MEL).

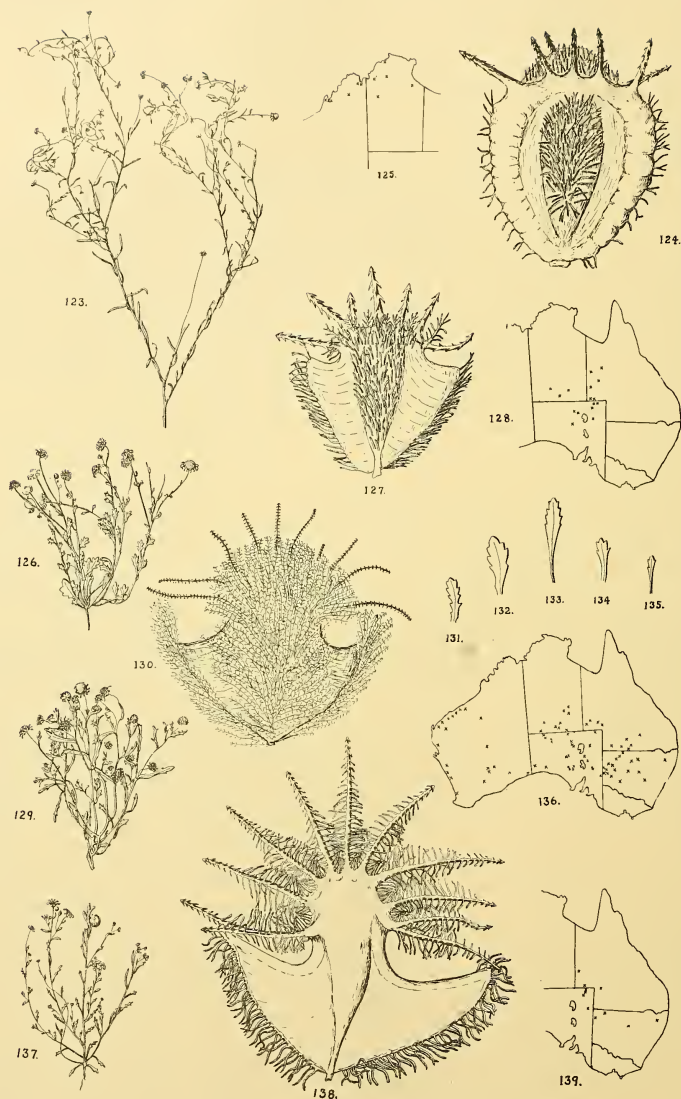
According to Bentham (1863) the types of the species described in "Enumeratio Plantarum" were deposited in Vienna, although duplicates of those collected by Bauer were in Robert Brown's collection. It is of interest that in the National Herbarium, Melbourne, there is a specimen accompanied by an envelope, with a single fruit, labelled in Sonder's handwriting "*C. breviseta* Benth. ex herb. Vindobonnensis", which presumably was removed by Sonder from the type material and has been used as a basis of comparison in the present work.

Mueller did not quote an exact locality for *C. tropica* ("In North-West Australia, generally in dry beds of rivers") but two specimens have been examined ("Towards the Fitzmaurice River and McAdam's Range" and "Upper Victoria River") which are accompanied by labels bearing Mueller's identification "*C. tropica*". Since these were collected four years prior to the date of publication of this species they are presumably at least part of the type series. A specimen from the last-named locality has been nominated lectotype, but Bentham (1866) is followed in regarding this species as synonymous with *C. breviseta*.

Type specimens of *C. pterosperma* ("Islands of the Gulf of Carpentaria, R. Brown") have not been examined, unless a specimen in the National Herbarium, Melbourne, labelled "*C. pterosperma* R.Br., North Coast, 1802-5, R. Brown" can be considered such. Since this and the original description agree with *C. breviseta*, this species is relegated to synonymy.

All the specimens examined were very similar in every respect, the small differences of the plants and their fruits being of no taxonomic significance.





Text-figures 123-139.

123-125, *C. breviseta*.—123, Habit  $\times 0.3$ ; 124, Fruit  $\times 18$ ; 125, Distribution; 126-128, *C. porphyroglossa*.—126, Habit  $\times 0.3$ ; 127, Fruit  $\times 18$ ; 128, Distribution; 129-136, *C. multicaulis*.—129, Habit  $\times 0.3$ ; 130, Fruit  $\times 18$ ; 131-135, Variation in radical leaves  $\times 0.3$ ; 136, Distribution; 137-139, *C. ancyrocarpa*.—137, Habit  $\times 0.3$ ; 138, Fruit  $\times 18$ ; 139, Distribution.

18. *CALOTIS PORPHYROGLOSSA* F. Muell. ex Benth., *Fl. Aust.*, 3 (1866), 505. (Text-figs. 126-128.)

*C. microcephala* F. Muell. ex Benth., *Fl. Aust.*, 3 (1866), 504.

*Type data*: "Cooper's Creek, Murray."

*Lectotype*, Cooper's Creek, 1862, Dr. Murray (MEL).

Septate-hairy annuals up to 40 cm. high, branching from the base and subsequently. *Cauline leaves* up to 4 cm. long, 1-2 cm. broad, narrow cuneate to cuneate, toothed or acutely lobed distally, sessile. *Radical leaves* of the same type, but petiolate, only present on young plants. *Inflorescences* about 1 cm. diameter, up to 100 present on a bushy plant. *Involucral bracts* about 30, 2.2-3.2 mm. long, 0.8-1 mm. broad, lanceolate, acute, entire and septate-hairy on the outer surface. *Ray florets* about 65, 3-4 mm. long, 0.6 mm. broad, bluish. *Receptacle* 1.6 mm. broad, 1.2-1.5 mm. high, steeply conical, moderately pitted. *Fruits* light to golden or reddish brown, 1.2-1.5 mm. long, 1.5-1.7 mm. broad, cuneate, flattened, body and wing margins bear white forked hairs; awns 6-11, rather unequal, 0.5-1 mm. long, rigid and barbed along their whole length.

*Habitat*: Grassland.

*Range*: Western Queensland and Central Australia.

*Specimens examined*:

*Queensland*: Cloncurry, herb among grass on the plains, eaten by stock, 1882, Palmer (NSW 14,911); Georgina River, E. J. Whelan (BRI); Boulia, in river channels, ca. 500 ft., tufted spreading annual, rays mauve, 28.6.1934, S. T. Blake 6,476 (BRI); Mulligan River, 2.1904, H. Clarke (NSW 14,910); 40 miles south of Birdsville, water-hole, Diamantina, 14.8.1934, J. B. Cleland (JBC).

*Northern Territory*: Stevenson, McDonald Ranges, 7.5.1894, R. Tate (AD); Ryan's Well, North of Alice Springs, 7.1922, C. E. F. Allen (NSW 14,908); Finke River, 1885-6, Dittrich (MEL).

*South Australia*: Near Eyre Creek, 1862, Murray (MEL); Pandie, Diamantina, 19.8.1934, J. B. Cleland (JBC; JMB); Minnie Downs, 1927, L. Reece (JMB); Alberga Creek, near Todmorden Station, 1.7.1920, H. W. Andrews (JMB); Ross' Waterhole, Macumba River, 5.1.1927, J. B. Cleland (JBC; JMB); Coober Pedy, 9.1935, C. French Jr. (MEL); Cooper's Creek 1862, Murray (MEL).

A haptotype of *C. microcephala* ("Murray and Darling Rivers, Herb. F. Mueller") has been selected which agrees with the original description in all particulars. The fruits are identical with those of *C. porphyroglossa*, but since only the small upper leaves are present an erroneous impression is created as to leaf size (Bentham: "leaves under  $\frac{1}{2}$  inch long").

Mueller (1866), in describing this species, commented on its resemblance to *C. plumulifera* (i.e. *C. multicaulis*), to which it is undoubtedly closely related. The fruits of the two species can be distinguished by the forked, rather than plumose, hairs on those of *C. porphyroglossa*, and the more robust and comparatively fewer awns. Vegetatively the resemblance is even closer, though the leaves of *C. porphyroglossa* tend to be more lobed than in *C. multicaulis*. It is always difficult to compare vegetative characters of specimens from different localities since the environment plays a large part in their development. In this instance, a folder from Coober Pedy was of considerable interest, since it contained a number of plants of both these species, which as they were intertwined, were apparently growing in close association. In this collection the two species were almost identical vegetatively, but easily separable on fruit characters, indicating that a genetic barrier to their crossing exists and that *C. porphyroglossa* is correctly regarded as a full species and is not, as suggested by Mueller (1866), a variety of *C. multicaulis*.

19. *CALOTIS MULTICAULIS* (Turczaninow) Druce, *Rep. Bot. Exch. Cl. Brit. Isles*. 1916 (1917), 611. (Text-figs. 129-136.)

*Goniopogon multicaule* Turcz., *Bull. Soc. Nat. Mosc.*, 24 (1851), 173; *Calotis plumulifera* F. Muell., *Trans. Phil. Inst. Vict.*, 3 (1859), 57.

*Type data*: "New Holland, Drum. IV.n.115."

Septate hairy annuals up to 47 cm. high, branching from the base and subsequently. *Radical leaves* oblanceolate and distally toothed, up to 4.5 cm. long, 8 mm. broad, petiolate, only present on young plants. *Cauline leaves* up to 4 cm. long, 1 cm. broad, narrow-cuneate to cuneate, distally toothed or with short acute lobes, sessile. *Inflorescences* 1.5 cm. diameter, over 200 on bushy plants. *Involucral bracts* 15-19, 2.5-3.6 mm. long, 0.6-1 mm. broad, narrow-lanceolate, acute to acuminate, margins microscopically serrulate, septate hairy on outer surface. *Ray florets* 12-20, the rays 3-4 mm. long, 0.6-1.1 mm. broad, bluish or white. *Receptacle* slightly taller than broad, 0.8-2 mm., narrow conical, moderately pitted. *Fruits* light to dark brown, 1.4-2 mm. long, 1.5-2.7 mm. broad, body cuneate, slightly flattened, usually densely covered with white plumose hairs which intermingle with those of the summit of the fruit forming a thick felt; wings rigid and thick with white plumose hairs along the margins, otherwise glabrous, but often obscured by the long hairs from the body; awns up to 24, but usually 12-14, of unequal length, 0.5-2.5 mm. long, frequently exceeding the length of the body, fine and flexible, with short straight hairs or barbed. Bases of the awns obscured by the white plumose hairs of the fruit apex.

*Habitat*: Flat, rather bare, areas of silty sand or loam, particularly on areas liable to flooding.

*Range*: Throughout inland areas of Australia with the exception of Victoria.

*Specimens examined*:

*Queensland*: Chatsworth, 13.9.1939, Hunt (BRI); Breadalbane Station, north of Bedourie, on silt beds, flooded ground, tufted dull green annual up to 4 inches, ray white, 23.7.1936, S. T. Blake, 12,339 (BRI); Mulligan River, 1885, W. H. Cornish (MEL); Monkira Station, 8.1891, G. L. Debnay (BRI); Currawilla, stallion paddock, in hard, pebbly, red-brown loam on bare patch, annual with several branched stems, 10.6.1949, S. L. Everist 3,939 (BRI); Nockatunga Station, between channels of the Wilson River, on loamy sand "clay pans" among Chenopodiaceae, ray white, 27.6.1936, S. T. Blake 11,829 (BRI); near Charleville, 9.1949, H. Harkin (MEL); Yowah Creek, near Toompine, slender herb in red alluvium, 21.9.1938, S. L. Everist 1687 (BRI); Thargomindah, 3.1885, L. Spencer (MEL); Goonamurra, slender herb very common on red soil flats, florets yellow, 20.9.1938, S. L. Everist 1,670 (BRI); Caiwarro, 1886, J. Cotter (MEL).

*New South Wales*: Glen Innes, 29.10.1886 (MEL); Hungerford, 9.1910, Bucknell (NSW 14,894); Thurloo Downs-Berawinia Downs, 10.1912, J. L. Boorman (NSW 14,888); Tarcoon, 11.1903, J. L. Boorman (NSW 14,958); Bourke district, 8.1896, J. H. Maiden (NSW 14,892; MEL); Bourke district, 5.1950, W. E. Darley (NSW 14,893), 29 miles east of Nyngan, 19.8.1939, I. Pidgeon and J. Vickery (NSW 14,897); Cobar, 8.1911, L. Abrahams (NSW 14,980); Yandanlo, 1886, B. Kennedy (MEL); Tarella, 4.1887, W. Bauerlen (MEL); Wilcannia, 8.1887, W. Bauerlen (NSW 14,886); Paldrumatta bore, Wilcannia, 4.1900, F. Corbett (NSW 14,891); Barrier Range, 1890, Irvine (MEL); Silverton, 11.1884, Harris (MEL); Broken Hill, white, 4.10.1920, A. Morris (NSW 14,896); Broken Hill, 21.5.1921, A. Morris (BRI); 90 miles east of Broken Hill, 20.8.1939, I. Pidgeon and J. Vickery (NSW 14,899); Menindee, Beckler (MEL); between the Lachlan and the Darling Rivers, 1885, J. Bruckner (MEL); Mossgiel, 1885, J. Bruckner (MEL); Parkes 22.9.1947, E. Constable (NSW 14,898).

*Northern Territory*: MacDonald Downs 22.8.1930, J. B. Cleland (JBC); Deering Creek, 1894, R. Tate (AD); near Henbury Craters, 19.6.1935, J. B. Cleland (JBC); 12 miles south-west of Henbury, 4.6.1935, J. B. Cleland (JBC); near Finke River, 1880, R. E. Warburton (MEL); between Angas Downs and Ayer's Rock, 9.6.1935, J. B. Cleland (JBC); between Charlotte Waters and Alice Springs, 5.1875, C. Giles (MEL).

*South Australia*: Abminga, 22.9.1945, J. B. Cleland (JBC); north of Musgrave Ranges, 7.1926, H. Basedow (NSW 14,874); Ernabella, 25.9.1945, J. B. Cleland (JBC); near Mt. Everard, 1882, E. Giles (MEL); between Ernabella and Echo Hill, 20.8.1933, J. B. Cleland (JBC; JMB); between Ernabella and Moorilyanna, 20.8.1933, J. B. Cleland (JBC); Alberga Creek, 1.7.1920, H. W. Andrews (JMB); 15 miles north-west of Oodnadatta, 22.8.1933, J. B. Cleland (JBC); 50 miles west of Oodnadatta, 5.8.1933, S. Neales (JBC); Warrina, 1890, Richards (MEL); Diamantina at Pandie, 20.8.1934,

J. B. Cleland (JBC); Waterhole, Diamantina, 14.8.1934, J. B. Cleland (JBC); Cooper's Creek, J. McLeod (AD); Cooper's Creek, A. C. Gregory (MEL); Lake Eyre, 9.1903, B. Spencer (NSW 14,877); between Hergott and Innanious Range, 6.1916 (JMB); Mt. Lyndhurst, annual, fodder plant, M. Koch (AD; MEL; BRI; NSW 14,884); Lake Torrens plain 28.8.1883, R. Tate (MEL); Curnamona, 2.12.1930, J. B. Cleland (JBC); Black Hill Wells, Koonamore, 15.8.1928, T. B. Paltridge (AD); Koonamore, 13.11.1924, T. G. B. Osborn (JMB); Mingary, 14.8.1921, A. Morris (JMB); Coober Pedy, 9.1935, C. French Jr. (MEL); between Kingoonya and Mt. Eba, 5.1917, H.B. (JMB); Tarcoola, 21.9.1920, E. H. Ising (BRI); east of Wingena, 30.10.1929, J. B. Cleland (JBC); Ooldea, 7.1921, J. A. Kershaw (MEL); Nullabor Plains, 1891, J. D. Batt (MEL).

*Western Australia:* Mulyie Station, De Grey River, spreading annual growing abundantly on flats liable to flooding, 3.8.1941, N. T. Burbidge (P); Rabbit Proof Fence, east of Gregory Range, rays blue, small annual, in sandy soil in depressions, 2.1.1947, R. D. Royce (P); Sherlock and Yule Rivers, 1878, J. Forrest (MEL); Nickol River, 1878, J. Forrest (MEL); Fortescue River, 10.1941, C. A. Gardner (P); Roy Hill, Fortescue River, 150 miles from coast, 14.5.1943, C. Davis (FAR); Cane and Ashburton Rivers, 1878, J. Forrest (MEL); Minderoo, Ashburton River, 9.10.1905, A. Morrison (P); Parker Range, 1892, E. Merrall (MEL); Gascoyne River, 1882, J. Forrest (MEL); Murchison River, 1892, I. Tyson (MEL); 91 miles east of Meekathana, 3-4", ray florets violet-lilac, in clay soil in depressions, 16.10.1945, C. A. Gardner 7,893 (P); Champion's Bay, 1871, Guerin (MEL); Irwin River, Oldfield (MEL); upper Swan River, 1888, M. Eaton (MEL); Laverton, 9.1900, J. H. Maiden (NSW 14,989); Glenom Station, Malcoim, 9.1938, N. T. Burbidge (P); Coolgardie, 7.1899, R. Helms (NSW 14,991); Victoria Desert, 16.9.1891, R. Helms (MEL); Eucla, 1889, Batt (MEL).

Although Turczaninow's type material was not examined, the identity of this species is quite clear. The monotypic genus *Goniopogon* was short-lived, as such, for its description was shortly followed by Mueller's description of *Calotis plumulifera* under which name Bentham (1866) listed this population, listing *Goniopogon multicaule* as a synonym. From 1917 to 1928 no less than four authors pointed out the priority of Turczaninow's epithet, Druce's publication of the new combination preceding that of Black by a few months. Among the specimens cited by Bentham (1866) is "Cooper's Creek, Gregory", a duplicate of which is in the National Herbarium, Melbourne. Since this specimen agrees well with both the original and Mueller's descriptions, it has been used as a basis of comparison by the present writer.

This species is usually easily identified by the densely woolly fruits with long fine awns, but certain specimens have been examined from Western Australia (Sherlock R., Fortescue River, Wongawal Sta., and Nickol River) and Queensland (Currawilla) in which the shorter plumose hairs exposed the glabrous portions of the wings, and whose awns were not as long as usual. On this account these fruits approached those of *C. porphyroglossa* but were nevertheless quite distinct.

The wings of the fruits are each of an equal breadth to the body and more or less abruptly terminated distally below the awns, but some variation was noticed, notably in two records from Western Australia (Meekathana, Lake Violet) in which they approached the typical anchor-shape of *C. ancyrocarpa*. Variation was also observed in the armature of the awns in specimens from Nullabor Plains in which they were microscopically barbed along their entire length and glabrous, while in a specimen from Warrina, the barbs were so minute they were hard to detect even microscopically.

20. *CALOTIS ANCYROCARPA* J. M. Black, *Trans. Proc. Roy. Soc. S. Aust.*, 45 (1921), 18. (Text-figs. 137-139.)

*Type data:* "Murteree, Strzelecki Creek, 9.1916, S. A. White."

*Lectotype*, Murteree, Strzelecki Creek, 25.9.1916, S. A. White (JMB).

An almost glabrous annual up to 22 cm. high, branching from the base and subsequently. *Leaves* cauline, up to 5-7 cm. long, 4 mm. broad, broad-linear to oblanceolate, with a few linear acute lobes. Upper leaves commonly entire. *Inflorescences* up to 100 on a much-branched plant, 1-1.5 mm. diameter, terminal and axillary. *Involucral bracts*



18-20, 1.6-3.6 mm. long, 0.5-0.9 mm. broad, linear to narrow-elliptical, subacute to acute. *Ray florets* 20-30, the rays up to 10 mm. long, 1.5 mm. broad, white. *Receptacle* hemispherical, 1 mm. broad, 1.2 mm. high, pitted. *Fruits* 1.2-2 mm. long, 2-2.5 mm. broad, light brown, glabrous except for the long simple hairs fringing the broad anchor-shaped wings. Pappus of 15-25 awns, 1-1.7 mm. long, stiff, with a few distal barbs with long simple hairs proximally.

*Habitat*: "Growing in tufts on the flooded ground" (field note of S. A. White).

*Range*: Western Queensland, north-western New South Wales and north-eastern corner of South Australia.

*Specimens examined*:

*Queensland*: Mulligan River, 2.1904, H. Clarke (NSW 14,905); Birdsville, on alluvial flats, annual to 6 in., ray white, 19.7.1936, S. T. Blake, 12,230 (BRI); Cuddapan, in grey clay near edge of melon hole, annual with numerous erect stems, ray florets white, 26.8.1949, S. L. Everist 4,060 (BRI).

*New South Wales*: Glen Innes, 29.10.1886, E. Betche (NSW 14,885); near Cobar, 9.1910, L. Abrahams (NSW 14,906); between the Paroo River and Grey Range, 1881, L. Morton (MEL).

*South Australia*: Flood plain of the Diamantina at Pandie Pandie, 18.8.1934, J. B. Cleland (JBC); Goyder's Lagoon, 15.8.1924, J. B. Cleland (JBC); Diamantina, 8.1930, Morgan (JBC; JMB); Murteree, Strzelecki Creek, 25.9.1916, S. A. White (JMB).

Variation is confined to the size of the plant and its leaves. All fruits examined were very similar, although in some the sinus at the apex of each wing was a little more pronounced than in that figured.

This is a very distinct species which, in awn arrangement and wing shape, most closely resembles *C. multicaulis*, which is found over the same area.

21. *CALOTIS BREVIRADIATA* (E. H. Ising), n. comb. (Text-figs. 140-142.)

*C. multicaulis* (Turcz.) Domin var. *breviradiata* E. H. Ising, *Trans. Roy. Soc. S. Aust.*, 46 (1922), 608.

*Type data*: "1552."

*Lectotype*, Hughes, N.P., 8.9.1920, E. H. Ising 1,552 (MEL).

Erect ? annuals up to 15 cm. high, branching from the base and subsequently, with an indumentum of white septate hairs. *Leaves cauline*, up to 2.5 cm. long, 4 mm. broad, cuneate, sessile, distally toothed or acutely lobed. *Inflorescences* about 50, 7 mm. diameter, axillary and terminal. *Involucral bracts* up to 36, 2-3 mm. long, 0.5-0.6 mm. broad, linear, entire, acuminate, with white septate hairs on margins and outer surface. *Ray florets* about 100, 1 mm. long, 0.5 mm. broad, apparently yellow. *Receptacle* 1.5-2.3 mm. broad, 1-2 mm. high, conical, moderately pitted. *Fruits* reddish-brown, 1.8-2 mm. long, 1.5 mm. broad, flattened; body oval, microscopically tuberculate, distal half obscured by straight white hairs; wings rather thick and rigid, distally convex and bearing long straight hairs along the outer margins. Awns about 20, 0.5-1.3 mm. long, unbarbed and provided with numerous hairs so as to appear plumose.

*Habitat*: No data.

*Range*: Nullabor Plains.

*Specimens examined*:

*South Australia*: Watson, 31.8.1950, J. B. Cleland (JBC); Hughes, 8.9.1920, E. H. Ising, 1,552 (MEL; NSW 14,904).

*Western Australia*: Eucla, 1889, Batt (MEL).

22. *CALOTIS ANTHEMOIDES* F. Muell., *Trans. Phil. Soc. Vict.*, 1 (1855), 44. (Text-figs. 143-145.)

*Type data*: "In muddy localities in the neighbourhood of Station Peak."

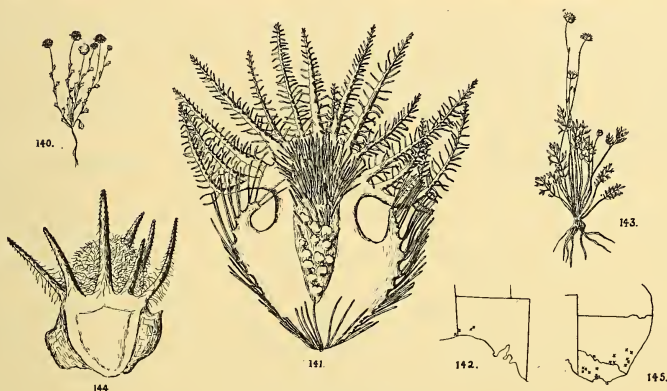
*Lectotype*, near Station Peak, in muddy places, F. Mueller (MEL).

Glabrous stoloniferous perennials with one to seven scapes arising from a basal rosette of radical leaves. *Leaves* up to 11.5 cm. long, bipinnatisect, the ultimate segments linear, acute, petioles almost as long as the dissected blade. *Scapes* up to 19.5 cm. high, slender, exceeding the leaves and provided with a few small entire or toothed bract-like

leaves. *Inflorescences* up to 1.5 cm. diameter. *Involucral bracts* 10-14, 3.5-4.2 mm. long, 1.2-3.5 mm. broad, ovate-lanceolate to orbicular, subacute to obtuse, entire with ciliolate margins but otherwise glabrous. *Ray florets* 50-70, 4.5-6 mm. long, 0.8-1 mm. broad, white. *Receptacle* 2 mm. broad, 1.5 mm. high, hemispherical with septa which enclose the base of each floret. *Fruits* reddish-brown to black, 2.5 mm. long, 1.7-2 mm. broad, the body cuneate, flattened, with rigid wing-like margins; awns 7-14, of unequal length, 0.2-2 mm. long, microscopically barbed distally, woolly proximally on inner surface. The apex of the body is covered with white hairs and forms a central cone which is usually exceeded by the longest awns.

*Habitat*: Swampy situations.

*Range*: Central and southern districts of New South Wales, western half of Victoria.



Text-figures 140-145.

140-142, *C. breviradiata*.—140, Habit  $\times 0.9$ ; 141, Fruit  $\times 18$ ; 142, Distribution; 143-145, *C. anthemoides*.—143, Habit  $\times 0.3$ ; 144, Fruit  $\times 9$ ; 145, Distribution.

#### *Specimens examined*:

*New South Wales*: Grenfell, 23.2.1947, H. F. McCarthy (NSW 3,086); Crookwell, 12.11.1937, W. A. Cady (NSW 14,627); Tarago to Braidwood, 29.10.1908, R. H. Cambage (NSW 14,625); Braidwood district, 3,000 ft., 11.1886, W. Bauerlen (MEL); Colinton, savannah, 31.10.1948, A. B. Costin (NSW 14,622); Wagga, 11.1885, R. Thom (MEL); Walbunde, white and yellow florets, common roadside weed, 17.9.1948, E. J. McBarron (NSW 14,621); Holbrook, 2 mile reserve, white-flowered swamp plant, 11.10.1947, E. J. McBarron (NSW 14,623); Edward's River, 1875 (MEL; NSW 14,624).

*Victoria*: Raywood, 26.8.1928, C. S. Sutton (MEL); Moyston, stiff clay, wet soil, D. Sullivan (MEL); Grampians, 11.1898, C. Walter (NSW 14,628); Dunkeld, pastures, 11.1901, H. B. Williamson (MEL; NSW 14,627); Skipton, W. T. Whan (MEL; NSW 14,982); Lara, 22.8.1923, H. B. Williamson (MEL); near Station Peak, in muddy places, F. Mueller (MEL); Geelong, H. B. Williamson (MEL).

Mueller's type series consists of six well-preserved specimens accompanied by his own label with the type data, and from these the lectotype was selected. All agree satisfactorily with the original description except that the disc florets are not hermaphrodite, as claimed by Mueller.

In a very variable genus this species is remarkable in its homogeneity in vegetative features as well as fruits.

#### *Acknowledgements.*

My thanks are extended to all who lent specimens for my examination and include the Directors of the various State herbaria as well as a number of private collectors. This revision was made possible only through their generous co-operation.

## References.

- BENTHAM, G., 1837.—Enumeratio Plantarum quas in Novae Hollandiae ora austro-occidentali ad Fluvium Cygnorum et in sinu Regis Georgii collegit Carolus Liber Baro de Hugel, 60. Vienna.
- , 1863.—*Flora Australiensis*, 1: 7-18. London.
- , 1866.—*Id.*, 3: 500-506.
- BLACK, J. M., 1921.—Additions to the Flora of South Australia. No. 19. *Transactions and Proceedings of the Royal Society of South Australia*, 45: 18.
- , 1929.—*Flora of South Australia*, Pt. 4: 589-592. Adelaide.
- BROWN, R., 1820.—*The Botanical Register*, 504. London.
- CHANG, CHAO-CHIEN, 1937.—An enumeration of Hainan Compositae. *Sunyatsenia*, 3, No. 4: 280.
- CHEESEMAN, T. F., 1925.—*Manual of the New Zealand Flora*, 1079. Wellington.
- DAVIS, G. L., 1948.—Revision of the genus *Brachycome* Cass. *Proc. Linn. Soc. N.S.W.*, 73, Pts. 3-4: 142-239.
- , 1950.—Revision of the Australian species of the genus *Lagenophora* Cass. *Id.*, 75, Pts. 3-4: 122-132.
- DE CANDOLLE, A. P., 1836.—*Prodromus Systematis naturalis regni vegetabilis*, 5: 302.
- DOMIN, K., 1929.—*Bibliotheca Botanica*, 89: 655, 1208.
- DRUCE, G. C., 1916.—Report of the Botanical Exchange Club of the British Isles. 611.
- GAGNEPAIN, M. F., 1921.—Composées nouvelles d'Extrême-Orient. *Bulletin de la Société botanique de France*, 68: 45.
- GRAY, A., 1861.—*Proceedings of the American Academy*, 5: 121.
- ISING, E. H., 1922.—Ecological notes on the South Australian Plants. *Transactions of the Royal Society of South Australia*, 46: 604.
- JOHNSTON, T. H., and CLELAND, J. B., 1943.—Native names and uses of plants in the north-eastern corner of South Australia. *Transactions of the Royal Society of South Australia*, 67, Pt. 1: 156.
- LEHMANN, C., 1845.—*Plantae Preissianae*, 1: 424. Hamburg.
- MAIDEN, J. H., 1908.—Notes from the Botanic Gardens, Sydney. No. 7. *Proc. Linn. Soc. N.S.W.*, 26: 84.
- , 1920.—Weeds of New South Wales. 12. Sydney.
- MERRILL, E. D., 1930.—Le genre *Tolbonia* O. Kuntze synonyme de *Calotis*. *Bulletin de la Société botanique de France*, 77: 341.
- MITCHELL, T. L., 1848.—Journal of an Expedition into the interior of Tropical Australia in search of a route from Sydney to the Gulf of Carpentaria. 75. London.
- MUELLER, F., 1852.—*Linnaea*, 25: 400-401. 471.
- , 1855.—Descriptions of new Australian plants, chiefly from the colony of Victoria. *Transactions and Proceedings of the Victorian Institute for the Advancement of Science*, 129-130.
- , 1859.—Some hitherto unknown Australian Plants. *Transactions of the Philosophical Society of Victoria*, 3: 57-58.
- and TATE, R., 1890.—Descriptions of new species. *Transactions and Proceedings and Report of the Royal Society of South Australia*, 13: 107.
- SONDER, W. O., 1852.—*Linnaea*, 25: 470.
- TURCANINOW, N., 1851.—*Bulletin de la Société Imperiale de Naturalistes de Moscou*, 24: 173.
- WALPERS, W. G., 1840.—*Linnaea*, 14: 307.
- WHITE, C. T., 1946.—Contributions to the Queensland Flora, No. 9, *Proceedings of the Royal Society of Queensland*, 57, No. 3: 28-30.

NOTES ON PHLEBOTOMUS FROM THE AUSTRALASIAN REGION  
(DIPT. PSYCHODIDAE).

By G. B. FAIRCHILD,  
Gorgas Memorial Laboratory, Panama.

(Communicated by D. J. Lee.)

(Seventy-seven Text-figures.)

[Read 30th July, 1952.]

*Synopsis.*

The present paper outlines the results of a study of more than 300 specimens of *Phlebotomus*, most of which were collected in New Guinea during the last war and a few from New South Wales and Queensland. Methods of study are detailed and following this is a systematic review of the species. The only earlier paper on this group in Australia (Tonnoir, 1935) described the first species of this genus to be recorded from Australia, comprising three species and one subspecies. These are discussed herein and in addition three new species from the Australian Mainland together with eight new species and one new subspecies from New Guinea. Notes are also given on the characters of other specimens from New Guinea which, owing to the fragmentary nature of the material, must await further collections before description. The paper includes keys to both sexes of these flies for both Australian and New Guinea species.

The material on which this study is based consists of 326 specimens mounted in balsam on microscope slides. The bulk of the material is from various localities in New Guinea and was collected by personnel of the 5th Malaria Survey Unit, U.S. Army, under the direction of Maj. M. S. Ferguson and Maj. Owen H. Graham, who have already published a preliminary note on the field aspects of their work (Ferguson and Graham, 1948). Some of this material was sent us for study in 1945, the rest being sent to Mr. D. J. Lee, of the School of Public Health and Tropical Medicine, Sydney, Australia. In 1948 Mr. Lee very generously sent us not only his part of the Ferguson and Graham material, but also some material from various parts of Australia collected by Miss K. English and Col. C. B. Philip. Subsequently we received some further New Guinea material collected by Lt. H. Hoogstraal and Dr. L. E. Rozeboom.

Some of the material had been stored dry in pill boxes, but much of it was preserved in alcohol. The dry material has made satisfactory mounts, though in many cases the specimens were somewhat broken or damaged by mites. The alcoholic material has been impossible to clear satisfactorily and has made very poor mounts, though in most cases comparison with the dry preserved specimens has enabled identification to be made.

Since so little collecting of these interesting insects appears to have been done in Australia, some brief notes upon their habits and habitats, and methods of collection and preservation may be useful.

Sandflies are small hairy midges 2 or 3 millimetres long, with a characteristic way of holding their wings out from the body and slightly tilted upwards. Their flight is short and hopping, and when walking they progress in a jerky, erratic manner. Most species are quite strictly nocturnal, hiding away during the day in holes and crevices which are reasonably dark and relatively humid. Holes and crevices in ruined masonry, stone walls, hollow trees and crevices between the buttressed roots of large trees, animal burrows and deep crevices in the soil, especially in arid regions, provide favoured daytime resting places. From these habitats the sandflies may be flushed with tobacco smoke and collected by the use of a suction tube. Some species are attracted to lights and may be taken in various types of light traps. Sheets of paper coated with castor oil and placed near likely looking habitats will often catch numbers of specimens.

Sandflies should not be stored in alcohol for more than a short time, as the tissues become altered so that subsequent clearing in KOH becomes difficult or impossible. Dry storage in small cotton-plugged vials with naphthalene or para-dichlorobenzene is more satisfactory, but it is best to clear and mount specimens as soon as possible.



Since most of the taxonomic characters are internal, sandflies must be cleared and in many cases mounted. For preliminary clearing, wet the specimens with alcohol and place in liquid phenol, made by adding a little water to phenol crystals, or in a moist atmosphere, allowing the crystals to deliquesce in an open watch glass. Specimens will usually be sufficiently cleared to allow the spermathecae to be made out in 15-30 minutes. Such cleared material should be further processed by treatment in 20% KOH solution without heat for about an hour, or by brief boiling, followed by thorough rinsing in water to remove all muscle and tissue fragments that may remain. The cleaned "skeletons" resulting may be stored indefinitely in 70% alcohol, or mounted on slides.

Due to the tenuous nature of some structures, especially the spermathecae, satisfactory permanent mounts in resinous media are somewhat difficult to make. The procedure devised by us (Fairchild and Hertig, 1948) has proved relatively reliable and consists essentially in the use of liquid phenol (carbolic acid) as the clearing and dehydrating agent throughout the process. Material previously treated with KOH and washed is placed directly into a weak solution of acid fuchsin in phenol, where it is allowed to stain for about fifteen minutes and the excess stain washed off in clear phenol. The specimens are then placed in a weak solution of gum copal in phenol which is allowed to thicken gradually over a period of days, thus infiltrating the specimens gradually with the resinous medium and avoiding shrinkage and collapse of the spermathecae. When the medium has become sufficiently thick, the specimen is dissected on a cover glass in a small drop of the copal-phenol, the wings, head, thorax and abdomen arranged in a uniform manner, and the preparation allowed to dry gradually. Chips of cover slip should be stuck to the corners of the cover glass to prevent crushing, and the whole preparation turned over onto a drop of thick xylol balsam on a slide. The finished mount should be thoroughly dried with moderate heat to drive off any remaining phenol which might otherwise crystallize in the preparation.

We have had no difficulty with this technique in Panama, where temperature and humidity are always relatively high. In cool or dry climates, however, crystallization of the phenol occurs quite rapidly. The use of beechwood creosote or lacto-phenol may solve this difficulty, though we have made no tests along these lines. The use of aqueous mounting media or those containing water-soluble gums or sugars we have found totally unsatisfactory under our conditions, no specimen so preserved having lasted more than two years.

The technique outlined above yields permanent mounts with each part of the insect in the same relative position on the slides, thus greatly facilitating the examination of long series of specimens. Being first mounted on the cover slip, the specimens are close to the glass and may be examined with the oil immersion lens. The use of glass chips at the corners prevents crushing and distortion, and the arrangement is such that the various parts are right side up when viewed through the microscope. We do not find that the removal of the cibarium and pharynx or the spermathecae is necessary if the specimens are properly cleared of tissue, as they are quite adequately seen through the posterior wall of the head capsule or the abdominal wall. In some cases it is useful to split the male genitalia sagittally to enable a clear view of the inner aspect of the coxite and paramere, but some specimens should also be mounted undissected.

The terminology adopted here is that used in a previous paper (Fairchild and Hertig, 1947). It is essentially that used by Tonnoir (1935), with slight modifications. The "cibarium" is the buccal cavity of Tonnoir. The "chitinous arch" is a thickening of the ventral surface of the cibarium, forming a more or less complete curved band across the cibarium between the armature and the base of the proboscis. It is believed to be the attachment of the salivary muscle. The detailed measurements of palpi, antennae, wing veins, etc., so much a part of earlier work on *Phlebotomus*, are believed to be largely unnecessary. By themselves they are seldom of much use in separating closely related species or in associating the sexes. Certain proportions, however, seem to be

valuable supplementary characters, such as the relative lengths of certain sectors of wing veins, the first flagellar segment (segment III) of the antennae relative to the palpi, and the length of the genital filaments relative to the genital pump in the male. It is felt that figures give a better idea than tables of measurements in any case.

The holotype, allotype and a series of paratypes, where available, of the new species described here are to be deposited in the collections of the School of Public Health and Tropical Medicine, University of Sydney, Sydney, Australia. A set of paratypes, where available, will be deposited in the U.S. National Museum, Washington, D.C.

### 1. THE AUSTRALIAN SPECIES.

No work on the Australian species seems to have been published since Tonnoir's paper (1935) in which three species and one subspecies were recorded from Australia. The present material consists of 10 specimens collected by Miss K. English at Yass, New South Wales, and 9 specimens collected by Dr. C. B. Philip at Cairns, Queensland. No information as to habits or habitats accompanied this material.

The 10 specimens from Yass consisted of 1 ♀ *brevifilis* Tonn., 1 ♂, 1 ♀ *englishi* Tonn., 1 ♀ *queenslandi meridionalis* Tonn., and 6 ♀ *brevifloides*, n. sp. The 9 specimens from Cairns consisted of 1 ♀ *queenslandi* Hill, 1 ♀ *peropharynx*, n. sp., 4 ♂ *buccinator*, n. sp., and 2 ♂, 1 ♀ undetermined. One or both of the undetermined males may be *queenslandi*. They differ somewhat in structure of the cibarium, but whether these differences are specific or not, only additional material will tell. We have refrained from placing them under *queenslandi* due largely to the greater number of cibarial teeth in our material, about 20 in one and about 30 in the other, whereas *queenslandi* is said to have from 15 to 17 teeth. Also the pharynges of our specimens do not agree well with Tonnoir's description in having "a comparatively small number of shallow scales arranged so as to give the impression of a loose and slender net". The undetermined female is represented by only the abdomen and a wing. The spermathecae are thin-walled elliptical capsules, much like those of *queenslandi*, which the specimen may be. Unfortunately the spermatheca of our single complete *queenslandi* was not drawn before mounting, so that detailed comparisons are not possible. We deem it better to leave these specimens undescribed until adequate material becomes available.

#### Keys to the Australian Species.

##### Males.

1. Style with three strong spines. Genital pump large, filaments short, less than twice as long as pump, heavily sclerotized. Abdominal hairs mostly erect. A few setae on lower border of mesanepisternum ..... 2.  
Style with four strong spines all very close to the apex and a single fine seta beyond the middle of the segment. Genital pump small and slender, the slender filaments more than twice as long as the pump. Abdominal hairs recumbent. No pleural setae ..... 3.
2. Aedeagus a pair of short truncated cones, poorly sclerotized. Plunger of genital pump slender. Style with basal spine longest, widely separated from the two closely approximated terminal spines ..... *brevifilis*.  
Aedeagus long, tubular, the tips up-turned, heavily sclerotized. Plunger of genital pump stout, the apex trumpet-shaped. Basal spine of style not longer than others, separated from the subterminal spine by about twice the distance between the subterminal and terminal spines ..... *buccinator*.
3. Pharynx hairy ..... *meridionalis*.  
Pharynx scaly ..... 4.
4. Cibarium with about 16 teeth ..... *queenslandi*.  
Cibarium with about 43 teeth ..... *englishi*.

##### Females.

1. Pharynx rather heavily sclerotized and pigmented on basal two-thirds, apex densely beset with spines in a rather characteristic fan-shaped whorl. Cibarium with five to ten well-separated horizontal teeth and often small fine lateral teeth. Spermathecae thick-walled or annulated. A few small setae on lower border of mesanepisternum .... 2.  
Pharynx less heavily sclerotized and pigmented; apical armature very much less prominent, consisting of scarcely pigmented slender scales or hair-like spines not arranged in a fan-like whorl. Cibarium with much more numerous, fine, closely set horizontal teeth in a comb. Spermathecae oval, very thin walled. No pleural setae ..... 4.

2. Pharynx shaped like an inverted flask, the anterior plate densely beset with small pigmented spines in a fan-shaped whorl; posterior plates with numerous longer spines. Cibarium with about 10 short stout horizontal teeth. Spermathecae with subspherical thick-walled heads and very long smooth ducts which join to form a common duct of appreciable length ..... *pexopharynx*.  
Pharynx less widened posteriorly. Spermathecae irregularly annulate, opening separately or with a very short common duct ..... 3.
3. Pharynx similar to *pexopharynx*, but the spines on anterior plate fewer and larger, on posterior plates longer and hair-like. Cibarium with five small well-separated horizontal teeth. Spermathecae with the anterior third irregularly annulate, the terminal knob sunk in a conical pit ..... *brevifilis*.  
Pharynx less strongly pigmented, the terminal armature of the same pattern as the preceding species, but much reduced as to both number and size of the teeth. Cibarium with six to eight pointed horizontal teeth and a number of fine, lateral teeth. Spermathecae as in *brevifilis* ..... *brevifiloides*.
4. Pharynx beset with rather broad-based denticulate scales. Cibarium with a comb of very fine long horizontal teeth, 77 to about 85 in number, and a few small erect teeth below ..... *englishi*.  
Pharynx beset with long slender spines. Cibarium with numerous well marked erect teeth below ..... 5.
5. Cibarium with a comb of about 45 moderately long horizontal teeth and with one and part of a second transverse row of well marked erect teeth below ..... *queenslandi*.  
Cibarium with a comb of about 75-80 very fine horizontal teeth and erect teeth below as in *queenslandi* ..... *meridionalis*.

PHLEBOTOMUS BREVIFILIS Tonnoir. (Figs. 3, 4, 9, 44, 47.)

1935, *Bull. Ent. Res.*, 26:145-147, figs. 2c, d and 3d. (♂, ♀; Canberra and Yass, N.S.W., Australia.)

*Phlebotomus (Australophlebotomus) brevifilis*, Theodor, 1948, *Bull. Ent. Res.*, 39 (1): 99-100, 105, 108; fig. 8.

A single female specimen, slide 1420, lacking the palpi, is in the collection. It was taken at Yass, N.S.W., in March 1946, by Miss K. English and is thus topotypical. We give here figures of wing, antennae, cibarium and pharynx. The spermathecae are visible but too distorted and shrunken to be worth figuring; they agree with Tonnoir's and Theodor's figures as far as can be made out. The ascoids appear to be broken, and are probably a little longer than shown in the figure. The specimen is quite pale, the mesonotum but slightly infuscated. The wing measures 2.05 mm. in length and is indistinguishable from the wing of *brevifiloides*. The proboscis is long, equalling the head height, there are no post-spiracular setae, and the abdominal hairs appear from their insertions to have been erect.

Theodor (1948) has erected the subgenus *Australophlebotomus* for *brevifilis* Tonnoir, placing it in the genus *Phlebotomus*. The characters used to distinguish the group are the presence of erect abdominal hairs, lack of, or rudimentary, cibarial armature, presence of but three spines on the style, rudimentary aedeagus and incompletely annulated spermathecae. The finding of other obviously related species in Australia and New Guinea necessitates a re-evaluation of *Australophlebotomus*. If *brevifiloides*, n. sp., *buccinator*, n. sp., and *pexopharynx*, n. sp., be considered to be closely related to *brevifilis*, as I believe they are, then but one of the characters cited by Theodor is shared by all the group, the presence of erect abdominal hairs. While it is true that *buccinator* and an as yet undescribed species from New Guinea have three-spined

Text-figs. 1-12.

Fig. 1, *P. hoogstraali* holotype, spermathecae, drawn in phenol before mounting, the junction of individual ducts not visible.—Fig. 2, *P. brevifiloides* paratype, spermathecae drawn in phenol before mounting; individual ducts probably separate to vagina.—Figs. 3 and 4, *P. brevifilis* female, whole pharynx and anterior plate only.—Fig. 5, *P. pexopharynx* holotype female, pharynx.—Fig. 6, *P. brevifiloides* holotype female, pharynx.—Fig. 7, spermathecae of, from top to bottom, *P. brachycornutus* holotype, *P. sansapovens* holotype, *P. fergusoni* paratype and holotype, and *P. dolichobysus* holotype, all drawn from mounted specimens.—Fig. 8, *P. pexopharynx* holotype, spermathecae drawn in phenol, parts of the ducts not visible.—Fig. 9, *P. brevifilis* female, cibarium.—Fig. 10, *P. pexopharynx* holotype female, cibarium.—Fig. 11, *P. brevifiloides* holotype female, cibarium.—Fig. 12, *P. papuensis* paratype male, cibarium. All figures drawn to the same scale with camera lucida, approximately  $\times 290$ .